The Journal
OF THE
Royal United Service Institution.

VOL. XX. 1876. No. LXXXVI.

Evening Meeting.

Monday, 31st January, 1876.

ADMIRAL SIR HENRY CODRINGTON, K.C.B., in the Chair.

NAMES OF MEMBERS who joined the Institution between the 18th and 31st January, 1876.

LIFE.

Montgomery, A. J., Lieut. R.A.

ANNUAL.

Thompson, W. H., Capt. 1st King's Dragoon Guards.
Rose, Henry, Commander R.N.
Aylmer, H. L., Lieut. 16th Lancers.
Hammond, R. H., Commander R.N.
Walker, Robert, Capt. Lon. Rifle Brigade.
Jones, R. W., Lieut. R.N.
Andrews, J. W., Lieut. 11th Regt.
Hastings, Warren, Lieut. 2nd W. I. Regt.
Patchett, W. Gordon, Lieut. 2nd W. I. Regt.
Murphy, J. A., Lieut. 2nd W. I. Regt.
Godwin-Austen, Fredk., Lieut. 2nd W. I. Regt.
Stanley, Edward, Lieut. 2nd W. I. Regt.
Thompson, J. H., Lieut. 2nd W. I. Regt.

PROPOSED NEW COMBINATION OF PROPELLERS FOR SHIPS OF WAR.

By GEORGE QUICK, Engineer, R.N., H.M.S. "Tenedos."

(Read by Captain J. C. Wilson, R.N.)

As the cost of each individual vessel of war is now much greater than formerly, so also is the individual importance of each vessel greater as it bears a larger proportion to the total naval strength of the empire. Thus, a modern ironclad costing £400,000, may be considered equal in importance in every respect (except number of crew) to a squadron of four or five of the line-of-battle ships of thirty years ago costing the same sum of money. Now, whilst it is hard to conceive any com-

bination of circumstances which would disable simultaneously a squadron of the old vessels, it is too well known that an ironclad of the same money and fighting value may be, and often is, disabled by a slight accident to her machinery. How much more frequently such accidents will happen, and how much more serious the injuries will be in war time, it is difficult to say, but that they will be more frequent and serious then than in time of peace, is, I think, to be fairly presumed. It is generally admitted, that in future naval actions the failure of the propelling power will place a vessel completely at the mercy of her antagonist, hence the safety of the ship depends entirely upon the retention of her motive power. Considering this, and the many sources of danger arising from torpedoes, ramming, &c., I cannot concede that even twin-screw propellers afford that security from total disablement which modern naval warfare requires. Being thus impressed with the necessity of greater security for the propelling power of war vessels, I have been induced to forward a certain proposal to the Admiralty for the purpose of providing it, an account of which I beg to submit to the consideration of the members of the Royal United Service Institution, in the hope of its receiving that free criticism which is always required for proposed innovations, and with the view of eliciting the opinions of those Officers who may have the great responsibility of commanding vessels in action.

Description of proposed new arrangement of Propelling Power for Ships of War.

The objects sought to be attained are, (1st.) Greater security for the propelling power and for the ship when in action. (2nd.) Greater economy of fuel at low speed with less wear and tear of engines and boilers than at present. (3rd.) To turn vessels quickly and in a very small circle, as well when they have no progressive motion as when moving at a high speed.

To attain these objects, I propose to supply additional engines for driving a turbine, or one or more centrifugal pumps for hydraulic propulsion, in such manner that when only a small speed is required—say under nine knots per hour—these engines can be used alone for propelling, and when higher speeds are required they can be used in conjunction with the screw engines. The discharge nozzles should be fitted with valves so as to allow the propelling streams from the turbine or pumps to be quickly diverted from going astern to a line at *right angles to the keel*, or right ahead, whenever it may be required either to turn quickly or to go astern, and the orifices for supplying the turbine with water to be fitted with valves that could be closed when required, so that in the event of injury to the ship's bottom from torpedoes or any other cause, the turbine would be able to draw its supply of water from the leakage, and by this means keep the ship afloat. Safety would be attained for the propelling power by thus dividing it into independent sections located in different parts of the ship; the different sections being used for different speeds; thus, the turbine could be used alone for speeds under seven or eight knots, the screw or screws being hoisted or placed vertically; for intermediate speeds—

say over eight and under twelve knots—the screw could be used alone; whilst for speeds over twelve knots, both screw and turbine could be used together.

Now, it is evident that for the same maximum speed to be attained in a given ship, at least the same total amount of steam must be supplied by the boilers, and that the power of the screw engines may be reduced in proportion to the power of the additional engines supplied for hydraulic propulsion. As an illustration of the application of this principle, I give the following:—Suppose a vessel is intended to have a speed of fourteen knots per hour, her nominal horse-power to be 1,200, and to indicate 7,200 horse-power. I propose to divide the boilers into three independent and isolated sections, one of 600 nominal horse-power, and two sections of 300 nominal horse-power each; with valves so arranged that all the boilers could be, if required, connected together, or any one section of boilers connected with any one pair of engines. By this division, the efficiency of a portion of the boiler-power is rendered more secure. As regards the engines, 900 nominal horse-power, equal to 5,400 indicated, would be appropriated for the screw-propeller or propellers, and 300 nominal, equal to 1,800 indicated, horse-power for the hydraulic propelling engines. Now, if a similar ship fitted only with the screw in the usual manner, has been propelled 14 knots per hour with 7,200 indicated horse-power, the speed of the proposed ship with screw-engines indicating 5,400 horse-power, will be 12·6 knots per hour, that is calculating according to the approximate rule that the speed varies as the cube root of the power:—

$$\text{Thus } S_1 = \frac{\sqrt[3]{\text{I.HP.}_1} \times S}{\sqrt[3]{\text{I.H.P.}}} = \frac{\sqrt[3]{5400} \times 14}{\sqrt[3]{7200}} = 12{\cdot}6 \text{ knots.}$$

With the hydraulic engines alone working at 1,800 indicated horse-power, the speed of the vessel will be 8·8 knots per hour:—

$$\text{For } S_{11} = \frac{\sqrt[3]{\text{I.H.P.}_{11}} \times S}{\sqrt[3]{\text{I.H.P.}}} = \frac{\sqrt[3]{1800} \times 14}{\sqrt[3]{7200}} = 8{\cdot}8 \text{ knots.}$$

Or if these hydraulic engines are used at half-power, = 900 indicated horse-power, the speed will be 6·9 knots, say 7 knots per hour.

It is evident that as hydraulic propulsion hitherto has not proved quite so efficient as screw propulsion, the extreme maximum speed attained by using the two together at the same time may not be quite so great as by the single screw using the same amount of power, but the enormous advantage of security to the propelling power and the ship, with rapidity of turning in action, *especially for ramming*, far outweighs a slight loss of extreme maximum speed, if any such loss should be experienced. In short, by the proposed combination of hydraulic and screw propulsion, all the advantages of both systems may be obtained in one vessel without the disadvantages attending on the use of either separately.

In proposing the preceding division of steam power between the

turbine and screw, I have considered that the former engines should be sufficiently powerful to enable the vessel to remain in action, by being capable of moving at an effective fighting speed, even if the screw engines should be entirely disabled; and I have estimated that 8½ knots per hour would be sufficient for that purpose.

But the proportion of turbine to screw-power may be very different from the foregoing, so as to suit the construction of the vessel or the service for which she may be specially designed. It is obvious that we cannot demand unlimited space and choice of location for our engines, but must make the best use of that which is assigned us. The following Table shows approximately the results which would be obtained by various proportions of turbine to screw-power, when the total steam power remained the same :—

Division of Power. Total 1,200 N.H.P.	Maximum speed in knots per hour.		
	Turbine alone.	Screw alone.	Both combined.
Hydraulic 1 to Screw 1 = 600 N.H.P. to 600 N.H.P.	11·1	11·1	14
Hydraulic 1 to Screw 2 = 400 N.H.P. to 800 N.H.P.	9·71	12·25	14
Hydraulic 1 to Screw 3 = 300 N.H.P. to 900 N.H.P.	8·8	12·6	14
Hydraulic 1 to Screw 5 = 200 N.H.P. to 1,000 N.H.P.	7·7	13·15	14
Hydraulic 1 to Screw 7 = 150 N.H.P. to 1,050 N.H.P.	6·9	13·3	14
Hydraulic 1 to Screw 9 = 120 N.H.P. to 1,080 N.H.P.	6·47	13·48	14
Hydraulic 1 to Screw 11 = 100 N.H.P. to 1,100 N.H.P.	6·1	13·56	14

The foregoing Table is calculated on the assumption that engines of 1,200 nominal horse-power would propel a similar vessel, fitted with the screw alone, at a speed of 14 knots per hour.

Applying this principle to a well-known vessel, Her Majesty's ship "Devastation," of 800 nominal horse-power, and taking the results of her trial trip as data, namely, speed 13·8 knots per hour, indicated horse-power 6,630, the following speeds would be attained by the turbine and screw respectively :—Turbine engines 200 nominal horse-power, speed by ditto, 8·6 knots per hour. Screw engines 600 nominal horse-power, speed by ditto, 12·55 knots per hour. If, however, the hydraulic propelling engines be of 100 nominal horse-power only, the screw engines being of 700 nominal horse-power, we get a speed of 6·9 knots by the turbine, and 13·21 knots per hour by the screw engines alone. The speed in each case with the combined propellers being 13·8 knots per hour nearly.

But if the screw engines remained as at present and room could be found for a pair of engines and turbine of only 50 nominal horse-

power, the speed by these small engines alone would be 5·47 knots per hour; whilst the efficiency and safety of this vessel as a fighting machine would be much increased by the facility afforded for turning in ramming and torpedo attacks.

In lieu of one pair of engines working a single turbine of great capacity, it would be possible, and in some cases desirable, to use two or more sets of independent engines and turbines of small power, and separated by water-tight bulkheads. But this is a matter which would be determined by the proportions and nature of the ship. Again, by the adoption of the auxiliary hydraulic propeller, a single screw may, in some cases, be used advantageously in lieu of twin-screws, by which considerable economy of space would be effected, and the coal-bunker capacity increased.

I have given no drawings to illustrate the application of this system, as the detail depends so much upon the nature of the vessel to which it may be applied.

From the foregoing it may be seen that the turbine may be applied as an auxiliary propeller in three different ways:—(1st) as a powerful auxiliary to the screw, capable of maintaining a ship in action after the screw engines are disabled; (2nd) as a feeble auxiliary, occupying little space, but sufficiently powerful to drive a mastless or other vessel for very long distances at low speed, which speed would not be sufficient for fleet actions or for heading against a gale of wind; (3rd) in very large vessels of the "Inflexible" type, whilst considerable turbine power may be supplied for propulsion, and located so as to exert its maximum efficiency for that duty, a small turbine may be supplied and placed in the best position to enable it to perform the special duty of quickly turning the vessel, and also for acting as a bilge pump and fire engine.

I anticipate great economy of fuel to arise from the use of the turbine engines alone, when a low speed only is required; the economy resulting from the use of small engines working at nearly full power, instead of using screw engines of great weight, frictional resistance, and large heat radiating surfaces at very low power. Having had occasion to study the effect of the reaction of streams of fluid for a special purpose, I have arrived at the conclusion, that for vessels of very fine lines, the turbine may be used for the sole propeller as efficiently as the screw, provided it be properly proportioned and constructed to suit the vessel and speed for which it is intended. The great point to be considered with regard to *full powered* turbine-propulsion is this, whether with a given cubic capacity, weight of machinery, and coal consumption, the turbine can propel a vessel at as great a maximum speed as the screw propeller can. If it can, then the turbine will rival the screw as a sole propeller. If, on the other hand, the turbine could be made, with the same bulk and weight of machinery, to give a greater maximum speed with the same economy of fuel as the screw, then it would totally eclipse the latter. On this question it is well to observe, that whereas thousands of screw-propellers have been made and tried, and are now fitted so as to be capable of being altered in pitch to suit the vessels to which they

belong, only a very few experiments have been made with hydraulic propulsion, and none at all, that I am aware of, of an exhaustive nature, involving alterations of the machinery.

But if we can only make the turbine within certain limits to approach the screw for speed and economy, then it may be used with advantage as an auxiliary propeller, in consequence of its capability of performing most important duties, other than propelling, which the screw cannot be made to do.

I have thus briefly stated my proposal for your consideration as Combatant Officers, for I venture to look upon it as your province to say whether auxiliary hydraulic propulsion should be used; and if so, in what proportion to the screw, and for what purpose; and the Engineer Officer's duty to be to design the most powerful and compact machinery to occupy the space and location the Naval Constructor may provide for it.

In conclusion I may state that I have designed means to obviate certain defects and difficulties which have been hitherto experienced in the application of hydraulic propulsion, and which have retarded its extension.

These means being, however, a matter of mere mechanical detail, I do not ask you to condescend to consider them, but to consider the important general question as to the desirability, or otherwise, of using hydraulic propulsion as an auxiliary to the screw in large vessels of war.

Addendum.

Since writing the preceding, news has reached me of the sinking of Her Majesty's ship, "Vanguard," of 5,312 indicated horse-power, by the "Iron Duke." This event must, I think, bring into prominence the question of the amount of pumping power required on board the fighting ships of the future; for the effect the sinking of only a single ship in action would have on the rest of the fleet to which she may belong, is a matter for serious consideration *now*. That the present pumping arangements on board ship are utterly inadequate to deal with such leaks as are likely to occur in action, and to steam vessels generally, is proved not only by the loss of the "Vanguard," but by the sinking of the "Ré d'Italia," "Flamstead," and "Ville de Havre," all of which were full-powered steamers. Other examples may be named, such as the screw sloop "Amazon," and many others. These cases show that the "bilge injection valves," so much relied on by marine engineers and shipbuilders generally, are totally insufficient to cope with the flood of water arising from collisions, and which will arise from injuries by torpedoes and projectiles. Now it being impossible to construct vessels which shall be invulnerable in all parts, it is necessary to consider these three questions:—(1st), the probable size of the breach, or orifice, which will be made by rams or torpedoes; (2nd), the amount of pumping-power requisite to prevent a leak of a given size from gaining on a ship; (3rd), the means to be employed for temporarily checking the rush of water into the vessel when the breach is very large indeed.

The first question cannot be definitely answered at present; as the exact size of apertures in the vessels sunk is unknown; and there is sufficient experience of the extent of the injuries which may be inflicted on iron vessels by torpedoes exploded in actual contact. The second question, however, can be easily solved for any particular case; and to afford a ready method of approximately estimating the power required for general cases, the following example is calculated for the particular case in which the breach is exactly *one square foot in area*, is at the mean hydraulic depth of *eighteen feet below the water line*, and the height of lift *twenty-five feet;* being the difference between the level of the water in the ship, and the surface of that outside. The assumed depth of the breach, and height to which the water must be lifted by the pumps, may be, I think, considered fair averages for a number of cases; but these two quantities may differ considerably from the above named values without greatly affecting the accuracy of estimates formed on those values—every foot of difference of level between the water inside and outside the ship affecting it to the extent of about *four per cent;* and every foot of difference in the mean hydraulic depth of the breach, from that assumed, to the extent of *three per cent.* The following is the calculation:—

Let A = Area of the breach = 1 square foot.

h = Hydraulic mean depth of breach below water line = 18 feet.

V = Velocity of flow of water through breach in feet per second = $8{\cdot}025\sqrt{h} = 8{\cdot}025\sqrt{18} = 34$ feet.

K = Coefficient of contraction of orifice due to friction of its edges, &c. = 0·8. (This value allows a fair margin for safety—the value derived from experiment on orifices in thin plates being about 0·6).

Q = Volume of water, in cubic feet, entering ship per second = A. V. K. = $1 \times 34 \times 0{\cdot}8 = 27{\cdot}2$ cubic feet.

d = Weight of cubic foot of sea water = 64 lbs.

W = Weight of the water must be lifted per second to prevent the leak gaining on the ship = $Qd = 27{\cdot}2 \times 64 = 1740{\cdot}8$ lbs.

H = Height which the water must be lifted to be discharged = 25 feet.

W H = Work in foot pounds to be performed per second = $1740{\cdot}8 \times 25 = 43520$ foot lbs.

Let x = Gross indicated horse-power of pumping engine to perform the work.

E = Net energy in foot lbs. = W × H.

k = Co-efficient of efficiency of steam engine = 0·8.

k_1 = Co-efficient of efficiency of centrifugal, or turbine-pump = 0·75.

k_{11} = Co-efficient of efficiency of engine and pump combined = $k \times k_1 = 0{\cdot}8 \times 0{\cdot}75 = 0{\cdot}6$.

Then $x = \frac{E}{550} \times \frac{1}{k_{11}} = \frac{43520}{550} \times \frac{1}{0{\cdot}6} = 131{\cdot}78$ I.H.P.

Say, 130 I.H.P. required to keep leak from gaining on a ship when the breach is *one* square foot in area, *eighteen* feet below water-line, and height of lift *twenty-five* feet, whence we can estimate the area of breach aperture that any given steam pumping-power is sufficient to contend with; or the pumping-power required for any given area of breach. This in the case of the "Vanguard" if one-third of the engine power, that is $\frac{5312}{3} = 1770$ I.H.P. had been applied to hydraulic propulsion, the area of the breach which could have been successfully contended with, by using the turbine as a pump, would have been $\frac{1770}{130} = 13{\cdot}6$ square feet. Or the amount of indicated horse-power requisite for a given area of breach is found by multiplying the number of square feet by 130, which gives the answer.

It may not be amiss perhaps to state the number of men which would be required to work the pumps continuously to prevent a leak through a breach of one foot square and 18 feet below the water line from gaining on the ship, as such a statement may dispel some vague notions on the subject. On the authority of Poncelet and others, Professor Rankine states that the work of an average man turning a crank, as in pumping, is 1,296,000 foot lbs., operating only eight hours a day. The work per minute would be $\frac{1296000}{8 \times 60} = 2650$ foot lbs., and $\frac{2650 \text{ ft. lbs.}}{33000 \text{ ft. lbs.}} = 0{\cdot}08$ horse power.

Now we have seen that 130 gross indicated horse-power = 79 net horse-power, would be required to perform the work to be done, hence $\frac{79}{0{\cdot}08} = 987$, is the number of men required at the pumps continuously; and of course double that number for spell and spell. By this we see the small utility of manual-power-pumps in contending with leaks or large fires.

To give a more popular illustration of the question, the weight of water entering a ship per minute through an orifice one square foot in area, and eighteen feet below water line, may be stated. As 1740·8 lbs. enter per second, 46·6 tons will enter per minute, and 2,796 tons per hour. This plainly shows the immense use watertight compartments have been in recent disasters in effecting a saving of life by giving time for escape; when, but for them, owing to the immense size of the breaches, the vessels injured must have been sunk almost instantaneously and all lives lost. I have no knowledge of the actual area of the breach in the "Vanguard," but taking into consideration the fact that it was nearly an hour after being struck before she sank, it may be safely concluded, I think, that if engines of 1,000 I.H.P. = say 160 nominal, had been applied in that ship to hydraulic propulsion, and the turbine had been used as a pump after the accident, that vessel would now be safely in dock undergoing

repairs. For we have seen from a foregoing calculation that whilst a hole a foot square will admit 2,796 tons of water per hour (quite enough to sink the "Vanguard"), yet we have also seen that an engine of only 130 indicated horse-power would discharge the same, lifting it a height of twenty-five feet. I have specially mentioned centrifugal and turbine pumps as no other kind is anything like so efficient for the power applied.

We now come to the third question: the means to be employed for temporarily checking the rush of water into the vessel when the breach is very large. It is unnecessary to say that a breach may be so large that if all the engine power in the ship were applied to the pumps, the leak could not be kept under for any great length of time, unless the rush of water could be reduced. But with the knowledge that there is very large pumping power on board, efforts could and would be made, not actually to stop the leak—that may be impossible—but to check it, so as to bring it within the power of the pumps. And as the pumps would prolong the time *between the injury of the vessel and the complete drowning out of the fires*, it is easy to conceive that time may be found to diminish the leak (by means of bags of oakum, large sails, awnings, &c., drawn over the apertures on the outside of the ship) to such an extent that the pumps may at last equal, or even master, the leak before the fires were extinguished. If they could not, it would be useless wasting time by attempting to work the hand pumps. But I think the time has arrived for special appliances for covering orifices and checking leaks to be supplied to fighting vessels. Such appliances could be made of large size, yet occupying little storage room on board, moderate price, capable of adapting themselves to any form or part of the vessel, strong enough to resist the pressure of the water on the back, and capable, by means of that pressure and its own elasticity, of forming a moderately good joint even in the case of the most ragged hole that a torpedo explosion could produce; and combining with these qualities the most important one of being quickly applicable to any part required under all circumstances, as well by night as by day. Such an appliance I cannot at present submit to your notice, but I may have, possibly, an opportunity of doing so at some future time, when I hope it may be found a satisfactory solution to the question suggested many years ago by the eminent engineer, Mr. Nasmyth, viz., *can "a hole as big as a church door in a ship's bottom" be stopped?*

I have to apologise for dwelling so long on so simple a matter of mere detail, but I have done so because I do not think it receives quite so much attention as it deserves, and also because *I do not consider that the giant steam power of our ships should be only available for mere propulsion and nothing else, when it is capable of a far greater range of usefulness.*

In conclusion I beg to state my opinion that, however perfect and powerful the machinery, pumps, and other appliances on board may be, the engineer officers must have very high moral qualifications—and I use the word *moral* in its widest sense—as well as first class mathematical acquirements, to make effective use of them, and to

develop their capabilities to the utmost limit in the moment of urgent need and danger. But to successfully cope with such exigencies and accidents as may and will arise in action, Engineer Officers should have more authority over the *matériel* and all the mechanical labourers afloat than at present, as well as a higher position as Officers to maintain that authority.

Admiral SELWYN:—I think we may congratulate the Navy on the possession of an Officer who can write such a paper, and who can entertain such views while he is still afloat, showing such little prejudice in favour of that to which he is accustomed, and which he has been principally working, for it is the one indication of progress when those who are actually working, not alone those who have worked in the past, or may work in the future, begin to consider what can be done to improve, and as boldly to state it. I have for a great many years in this Institution, strongly advocated going much farther with the hydraulic propeller, which I believe is possible, but I will confine my remarks to the view which Mr. Quick takes of its utility, first, as an adjunct to the screw, and secondly, in its character as a pump. There is no doubt, first of all, that our experiments with the hydraulic propeller have hitherto been of the most unsatisfactory character as regards the records made of them, the opportunities given for studying them, and the attention paid to them. Had the screw been treated with as great a neglect as the hydraulic propeller has been, had it been so little backed up by capitalists and others, I doubt whether we should have had the screw to-day, but I am quite prepared to think not so great an improvement was made by the substitution of the screw for the paddle, as will eventually be made by the substitution of the hydraulic propeller for the screw. I remember perfectly well those who advocated the use of the screw were met with the statement, that it could never be used except as an auxiliary, but that idea has of course been given up long ago. I think, however prudent it may be to put one foot forward at a time, and to introduce the hydraulic propeller as an auxiliary, we shall yet very soon after we begin to understand its uses and its efficiency, regret that we ever took it as an auxiliary only. The great point which Mr. Quick has not adverted to in his estimate of its efficiency is this, that whereas in the paddle and screw we are dependent on the immersion of the ship for the power which may be developed by any amount of engine-power you put on board that ship, the hydraulic propeller has no such limit, as it derives its effect from reactive efforts alone. Any amount of power that can reasonably be put into the ship and for which fuel can be found may be usefully exerted at all times by the hydraulic propeller, while with the paddle in rolling, or the screw in pitching, a very large proportion of the power is lost. I think in cases where a vessel is fitted as he proposes with a combination of these two propellers, the screw and the hydraulic, and in a heavy following sea, with the screw doing nothing but attempting to break the engines down, slowly propelling the ship ahead, but causing everybody the greatest anxiety lest the engines should be broken down by the racing they are subjected to, —here I believe the screw might be let alone altogether, and the small hydraulic auxiliary power would do quite as much duty without any waste whatever; that is to say, the ship would go ahead as fast with a very small auxiliary hydraulic propeller as if you were using the large effort of the screw only partially effective; and that would be a very great advantage. There is no doubt also that the screw is subject to many exterior accidents to which the hydraulic propeller is not liable, and that in action these would be multiplied not only by the efforts of the enemy to ram the ship, or from any accident occurring from torpedoes, but also from the unavoidable fouling in a sea which would probably have floating wreck in it, for as you go about in a heavy smoke, not able to see and to steer clear of floating wreck, you must necessarily expect occasionally to foul the screw. This would reduce the ship to a condition of absolute helplessness, and in such a case the hydraulic propeller would have a very great advantage. I think there must have been some error in Mr. Quick's calculation with regard to the manual power required in lifting-water. I am glad to say it is all on his side; he has made a very wise error if it is an error, but I do not think even Poncelet and Rankine would ever tell us the efficiency of

one man is one ton a minute, one foot high of water lifted. There is some mistake which very often occurs in these cases,—that is all in his favour; it would show that the 130 horse-power would do more than he states.

Captain WILSON: Mr. Quick states that a man is capable of raising 2,650 foot pounds per minute, equal to 0·08 horse-power.

Admiral SELWYN: We all know what a very wearing-out business pumping is if you come to put men at it; they rarely do their work quite as an engineer would desire to see them do it. Mr. Quick gives us some very useful figures if we apply them generally. I see he says this must be a function of the immersion of the ship, and a ship at sea is always varying her immersion at any one point. She may be rolling. She may roll the leak higher up, or she may be subjected to such a swell as leaves the leak occasionally almost bare. Supposing she has a leak in the fore compartment, and is running at high speed; it is clear the water will enter with a greater velocity; so that his figures will require revision before we accept them as anything on which we can put a fair estimate of what may be done. I think we must recognise the fact that the hydraulic propeller does present to us for the first time the means of utilising a very large proportion of engine-power on board a ship to encounter those enemies which seem most likely to be formidable in modern warfare, the ram and torpedo, and those which most seamen will view with the greatest dismay, simply because they are not to be guarded against as we can guard against many other things of the kind. Call it a great pump, rendered necessary by modern conditions, and I think even on that view of the question we shall be prepared to accept such an auxiliary power for this purpose; but if we can get by any process whatever a series of experiments tried with the inefficient application of the hydraulic propeller we have got at present,—fairly tried to the bitter end, giving the actual results tabulated in such a way as that the whole profession can avail themselves of them, then we shall be able to go ahead; we shall be able to detect the points in which the hydraulic propeller has not proved thoroughly satisfactory. It may, however, be claimed that a very large amount of satisfaction has really arisen, and that from the first application of it, it has not proved inefficient,—the ship is still going about,—I say by this means we should be able to make progress in a direction which will have, I am sure, very great value. There is another point about the hydraulic propeller which is one of its great excellencies, that if we choose, and it seems likely we shall have to choose, to mast our ships again properly, and to give them efficient sail power, it does not offer any of those obstacles to rapid motion under sail which the screw must necessarily do, still less does it make a great difficulty in the steerage which the screw always must do. You cannot with impunity have a large vacancy close in front of the rudder if you desire to have a ship that will steer well as we used to consider ships ought to steer, and the hydraulic propeller will give us a machine which will not have that disadvantage. Also on the question of grounding, it is well known in a late case off the coast of England, the very first attempt to back the ship astern after grounding resulted in the breaking of the propeller. The hydraulic propeller is subject to no such contingency, if the points at which the water is taken in and given out are properly chosen. A ship may get on shore, and lie on sand without any danger to the machinery outside the vessel, and that is to be reckoned as one of its advantages. In all these things I think Mr. Quick is taking a line which will, I hope, lead him to a thorough study of the question of stopping leaks. We have done that very efficiently at sea formerly, when we did not expect any such large holes in the ship's bottom, but there may be no doubt means devised for making canvas more water-tight than it is under such pressure as that. Although canvas answers absolutely well up to a certain pressure, there is a pressure beyond which the water is forced through the canvas, and that would be speedily reached with such depths of leak and such weights to support as might now occur. Some people think that the use of india-rubber may be possible, but I distrust it very much where it is alternately wet and dry. Vulcanized rubber is subject to decay, to slow oxygenation of the sulphur used which decays the whole rubber, and you cannot preserve diving dresses in hot climates unless you keep them always under water. And then they are subject to another slow decay, which is the combination with hydrogen, but it is slower than the oxidization. I can only express my high appreciation of Mr. Quick's paper, and

I hope many such papers will follow, in order to establish the value of the hydraulic propeller.

Captain WILSON: I think this is a step in the right direction, for it is a very important thing to have a large pump in these large ships. I have no opinions myself on the subject of hydraulic propulsion: I have not had any experience on the subject, and really have not studied it, but I do think it would be a very good thing if we could possibly get a large pump that can be used for slow speeds and for pumping a ship out in case of collision or having a hole knocked in her bottom by torpedoes. I do not think it is wanted much for fires. I think the water supply for putting out fires is perfectly well provided for; it is not the quantity of water to be used, it is the application of the water, and therefore I do not think that the turbine pump is at all necessary. But I think, for such accidents as have recently occurred in the Channel, a small turbine engine would be extremely useful in a ship, and also, as is very well put by Mr. Quick, for turning a ship readily to meet the attacks of a ram or of torpedo-vessels. But the obvious difficulty, I think, is the question of extinguishing the engine-fires. I think whenever a large hole is knocked in a ship's bottom, unless you have your fires placed so high that you will be able to keep steam up in a special boiler, before the turbine could be really of any value the fires would be extinguished and it would be useless. It may be answered to that, that that is a matter of detail which may be got over if the stoke-hole fires are so placed, or a certain portion of the stoke-hole fires are so placed, that a special boiler can be always used, even if there are a certain number of feet of water in the ship. Then I think a turbine centrifugal pump would be extremely useful on board a ship, especially if it can be used to relieve the engines when going at small speed. The difficulty, especially in turret ships, would be to keep the sea, and it would be a very great matter if economy of fuel could be effected by using a small engine, whilst always keeping your large engine ready in case of need. In the same way one of the difficulties of protecting trade would be the question of fuel, and the small turbine power would be extremely useful there. I am also quite of Admiral Selwyn's opinion that if it can take the place of the screw, it will be a very great advantage, because then you can have your ships fully rigged and entirely dependent on sail power, excepting for the supreme moment of action, or when steam power is absolutely necessary under certain circumstances. It appears always to me the difficulty which hardly ever has been faced, and hardly ever has been talked very much about, in the event of war, in protecting our trade, will be our coal depôts. We do not keep large supplies of coal abroad, and how are we to keep these depôts up? We should require to convoy colliers, or something of that sort, which would take a great deal of our fighting power, or otherwise they would never be able to fetch the different points against an active enemy. Our enemy would not require depôts, for any second or third-rate naval power, if they sent to sea a very few ships, could prey upon our trade, and every one of our first-class ocean steamers would be to them a coal depôt and a provision ship, and when they could not find any more such coal or provision depôts on the ocean under our flag, their work would have been accomplished, and they could go home happily, having no further reason to remain at sea. But with us it is the reverse. We must depend upon our depôts so long as we have the command of the ocean, and it will become a very serious question whether our depôts of coal would be equal to the demands upon them; and if they are not, it will be very, very necessary, that our ships should be supplied with sail power, so as to economize coal; and turbine engines supplied to our frigates for the protection of our trading vessels would be a very great assistance. And even supposing we keep the screw, small turbines applied to some of our larger vessels of the "Inconstant" class might be used in calms and light weather with great advantage and economy; and in the event of their getting a hole knocked in their bottom as big as a church-door, as Mr. Quick suggests, we might still be able to keep them afloat.

Captain SIMPSON, R.N.: Captain Wilson has spoken of the economy of fuel given by the hydraulic propeller. Now, I very much doubt if we shall get economy of fuel by the turbine. I think Admiral Selwyn says we have not had sufficient trials with the turbine to decide this point, but the trials we have had certainly do not prove that we gain anything like an economy of fuel with the turbine, and I think it would be utterly impossible that it ever can equal the screw or paddle in this respect. Perhaps

that has to be tried, and if there is any doubt in the matter it ought to be set at rest.

Captain WILSON: As an auxiliary.

Captain SIMPSON: If the turbine is not an economical propeller for full power, I do not see why it should be good for an auxiliary. If you simply require a powerful pump, of course that is another matter.

Captain WILSON: And for turning power.

Captain SIMPSON: No, I do not think it has equal turning power to the screw. You have your rudder power with a turbine very inferior to what it is with a screw. The screw throws a stream of water upon the rudder and turns the ship very much more rapidly than the paddle or turbine.

Captain WILSON: I am arguing from Mr. Quick's point of view. I think his suggestion is, you can turn at rest.

Captain SIMPSON: Yes, and that also can be done with the paddle—you can turn the ship on her centre, and that under certain circumstances has its advantages; but I imagine no ship in an action at sea would venture to stop and turn in that way: she would inevitably be rammed by any ship that kept her way whilst turning. And, besides that, you turn very slowly, turning the ship in that way; you get her round in a very small space, but you do not get her round rapidly. Your rudder has infinitely less power with the turbine than with the screw. And as for the rolling motion, it is true with the paddle, one wheel gets deeply immersed and the other is out of the water; but with the turbine, one orifice is by the rolling motion raised high above the surface of the water, and occasions a great loss of power by requiring the turbine to lift the water that height to discharge it, while the other orifice is immersed, which is also a drawback, because the nozzle is thrust into the water and the flow of water is therefore not so rapid or so good as when the nozzle is above the surface. In rolling I fancy there will be very little difference as to the loss of power between the turbine and the paddle, and may be considered about equal to the loss by the screw with the pitching motion.

Mr. WILLIAM SMITH, C.E.: I think it may be interesting to the meeting to know that, when Mr. John Elder read a paper here upon circular ironclads, about eight years ago, he proposed, for the purpose of manœuvring his circular ironclads, to employ the turbine, and, if you refer to the Journals of this Institution, you will find diagrams given of a form of circular ship, proposed by Mr. Elder, not simply a section of a sphere, as it has been reported, in various newspaper notices, of Admiral Popoff's vessel. But the point to which I wish to call attention is that Mr. Elder proposed, for the purpose of manœuvring circular ironclads, the hydraulic propeller, and the experiments made in Glasgow show, very clearly, nothing could be better adapted for the purpose than the hydraulic propeller, applied in the way in which he proposed to apply it. On the question of the comparison between the paddle-wheel and a hydraulic propeller, I do not know any naval Commander of the present day who would desire to fight a paddle-wheel ship in action—he must be a very bold man to do it. As comparing it with the screw, even the twin screw, I consider a properly arranged hydraulic propeller presents a great many advantages as compared with screw, paddle, or any other contrivance for propelling, but particularly in the case of manœuvring. You need not depend upon the use of the rudder at all, for, by means of the glivée valve arrangements, which have been very well worked out for the purpose, there is no earthly doubt you could manœuvre a ship in any direction you pleased. And one of the applications of the circular ship of John Elder's was really to make a horizontal revolving saw, and it was shown by experiment that the centripetal action of that rotating body was so great, that nothing on earth would have resisted the cutting down power of that ship, rotating at a speed perfectly possible to be given to it, with the power he proposed. I think there is a very great field for investigation offered by the consideration of the hydraulic propeller as a propelling and manœuvring engine, but more particularly for manœuvring, and, if the Admiralty could be induced to re-open that question, and to have a series of experiments tried, it would be a very great step gained towards doing for the hydraulic propeller what has been done for the screw for so many years past. The paper read is one deserving of the very highest encomium. It is very pleasing to see, as has been remarked already, an Officer actually engaged in

service at the present time, giving his thoughts such a practical direction as Mr. Quick appears to have done. I wish him every success.

Captain BURGESS: If you look at the proceedings of Lord Dufferin's Committee, on "Designs for Ships of War," you will see that that Committee strongly recommended that further trials should be made with the turbine propeller, and Admirals Elliot and Ryder in their Report did the same.[1]

The CHAIRMAN: I am sure that I feel very much, as all of us do, indebted to Mr. Quick for having brought the subject so well before us. That the turbine principle has not been properly tried, I am convinced. I have only seen one vessel, and from what she did, or rather what she did not do, I had my doubts as to whether she was in that condition in which she might have been. We find now that a better arrangement might be made, and I think there is a great deal that can be done with the turbine; but it is all in the working out of the principle. I do not think the "Waterwitch" was sufficiently fitted, and therefore it was not a very fair trial, on the whole. I very much regret that the system has not been tried more, and more with the view Mr. Quick now advocates, because there are many other ways, as gentlemen have stated this evening, in which it may be most useful. I can conceive, in action, it is less liable, by far, to be disturbed by the accidents inevitable in a naval fight. Though it may not possibly (I am not quite certain it would not) give the same speed under the varying circumstances of wind and weather, apart from other considerations, as other methods of propulsion, yet if it will give us that speed, or something like it, under the circumstances in which these other means of propulsion will be liable to be disabled, then it will certainly be a very valuable thing. With respect to pumping, I do not see its application quite to extinguishing fire, but for pumping out from a leak, I see very great possibilities indeed, provided we have an instantaneous means of efficiently shutting off the supply to the turbine, and of taking that supply from the leak. These are questions of fitting, and it is, after all, on the accuracy of these fittings that all these new inventions depend. A new invention which is not well looked after, and which is not very well fitted, has very little chance, I won't say merely with the Admiralty, because, after all, the Admiralty are only representatives of public opinion in the Navy, and in general I may say this for the Admiralty, though I am not in any way connected with it, that they have rather a hard task sometimes to fulfil, with respect to inventions, and first of all, to see that they are likely to answer. Everybody who knows anything of Admiralty business knows that there is far more business than any number of men can do efficiently in that building, and a great number of inventions are brought before them, and they have a very difficult part to play to know what to do with those inventions. It is not every man that can immediately see, in the midst of his many official duties, how a certain invention may turn out, particularly when it has not been very effectively brought before him; so that we must not be too hard upon the gentlemen sitting there, whose time is very much occupied in the public service of the country, and who have scarcely time to attend to the wonderful and numerous inventions that are cropping up every day before us. In short, not being an office man myself, I can quite feel for them, and we must not deal too hardly with them. I do sincerely hope, after this paper and the renewed attention that has been given to the subject, they may be induced to take the question up again, and give it a chance of developing itself and showing what may be made of it. I feel convinced myself much more may be made of it than has yet been done by the "Waterwitch," and I only wish it may be tried.

[1] It appears pretty clear that had the "Vanguard" been constructed on the elaborated cellular system, so strongly recommended by the above Officers, and had she had in addition a turbine propeller, she would have been afloat now.

Fig 1.

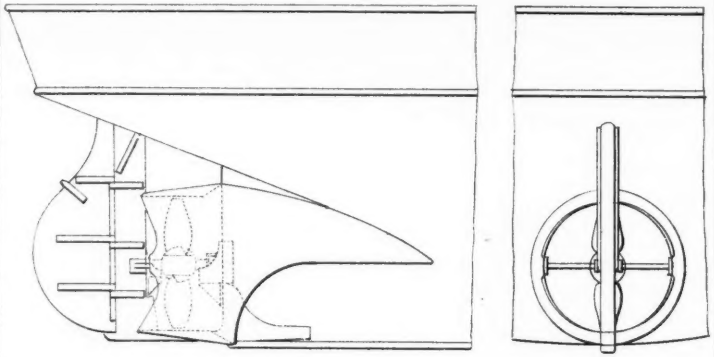
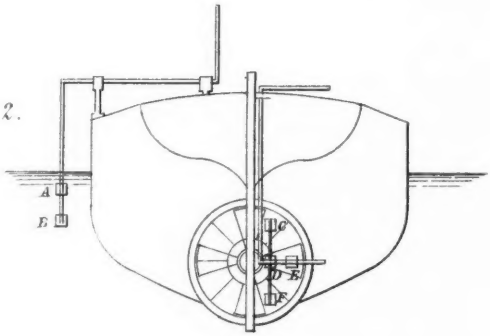
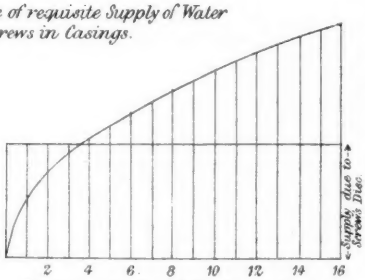


Fig 2.



Curve of requisite Supply of Water for Screws in Casings.

Fig 3.



ON THE CASING OF THE PROPELLER OF H.M.S. "BRUISER."

By R. Griffiths, Esq., C.E.[1]

The plan of casing the screw propeller has often been proposed and practically tried by several inventors, but caused in every case a loss of speed, which could not be accounted for at the time; in some of the experiments the casing was attached to the periphery of the screw, and revolved with it; and, in the others, the casing was fixed to the ship, and the screw revolved in it; but in each case I found, by experiments I made, that the loss of speed was due to the screw being short of water, when the casing was only made the length of the screw, for a considerable portion of the water that the screw-propeller forces through its disc is drawn into it from around its periphery; so that when the screw had a casing over it, it was deprived of all its supply, except that which entered on the face of its disc.

There has been—I may say universally—an opinion, that whatever the distance gone by the ship, was short of the distance the screw would have gone if it had been working through a solid, which is termed the slip of the screw, was a loss of power; and there have been several papers read at different Scientific Institutions to attempt to prove this theory. I have always opposed this theory, for I saw in 1849, when I made my experiments on screw-propulsion, that the water was forced back from the screw at nearly twice the speed the model was moving, and that the model would not move forward unless the water was forced backwards from the screw's disc. In order to give the screw of the "Bruiser" its full supply of water, I had the casing made of boiler plate of 7 feet diameter where the screw worked, and tapered to 6 feet 2 inches diameter at the after end; it was lined inside with wood, making it parallel where the screw worked, and tapered from the forward edge of the screw to form a funnel mouth, which gave about 35 per cent. more entrance for the water to get to the screw; when finished it did not appear to allow as much extra entrance for the water as I imagined to have given the best results in my model trials; I therefore had a lip of plate iron attached below the casing, allowing about 5 per cent. more, making altogether about 40 per cent. more entrance for the water to supply the screw than the area of the screw's disc. This I found since to be little more

[1] Read at the Evening Meeting on Monday, 31st January, 1876. Admiral Sir Henry J. Codrington, K.C.B., in the Chair.

than is required for a screw that has only 7 I.H.P. per square foot of the screw's disc, which was the proportion in the "Bruiser;" for the supply of water requires to be in proportion to the power exerted on the propeller, as shown by the diagram, Fig. 3; hence a small screw can be made as effective in propelling as a large one within certain limits, if it can obtain a sufficient supply of water. A screw propeller is simply a rotary pump, when in a casing, and is governed by the same laws, viz., that the power varies as the square of the velocity, so that to double the velocity of the water you drive through a pipe, or through the casing of a propeller, you require four times the power, and four times the thrust is given to propel the ship.

Diagram No. 2 is that of a steam launch with which I tried some experiments at Devonport, with a view to ascertain the quantity of water the screw required. These experiments showed that when the launch was moored, and the engines worked up to the same speed as when she was going—viz., 240 revolutions per minute—the force of the water which came from the screw, gave about one-half the pressure upon the gauge-plate as it did when the launch was going at the full speed of six knots, with 240 revolutions per minute. This shows clearly the mistake of the theory of engineers that when the screw was placed where the water had free access to it, the quantity driven back would be a column the same diameter as the screw at the speed the launch went; for these experiments show it to be about 50 per cent. more.

One of the most important points in screw-propulsion is to get a sufficient supply of water to feed the screw in proportion to the power that is exerted upon it. On the present system this is all taken from the stern of the ship in front of the screw, and as the ship moves forward, the water must close in behind her in order to fill up the space she occupied, and the screw is drawing away the water from where it is most required, and thus causes much greater resistance to her than if she were propelled by sails or paddles; and this resistance increases in proportion to the power and speed of the ship. It is well known that out of the power exerted to propel a ship by the screw, there is about 60 per cent. loss, so that 40 per cent. of the power, if exerted to tow her, would give the same speed to the vessel. I have tried the model which I use for my experiments, and with the spring which took one minute to propel it 60 feet, with 600 revolutions by the screw, it was towed the 60 feet in 33 seconds, with 600 revolutions, by a string wound on a drum, the friction being the same in each case except the friction of the screw in the water, which must be considerable.

In order to reduce this enormous waste of power in propelling by the screw, I have devoted a considerable amount of time and money, and the conclusion I have arrived at is that, unless the screw gets *fully* supplied with the water it requires to drive through in proportion to the power exerted by the engine to work it, it will not give a relative thrust to the screw-shaft for propelling the ship; and, in order to obtain it, I have been able to discover no better way than to enclose the screw in a casing made with a funnel-mouth at the entrance, of such proportions

as will admit the quantity of water which will be required, according to the amount of power that is to be exerted upon it.

There is another important feature in connection with the supply of water to the screw,—viz., the use made of it after it has passed through the screw, as well as where it obtains its supply from; for I have already observed that the screw in drawing the water from the stern of a ship causes much greater resistance to her; and I find the water should be supplied to the tunnels from underneath the vessel, as far forward as not to take it from or stop the supply that is required to fill the space that has been occupied by the ship, and delivered from the screws into the space left by the stern of the vessel; and as I have already shown that the screw delivers from 30 to 100 per cent. more water than is due to the speed of the ship, according to the power exerted to work it, so must her stern be made full to leave room for it as it leaves the casing and propellers, and in that case I find there will be very little disturbance caused by the screw in the water behind the stern of the ship when under way.

The speed of the "Bruiser" when tried before the casing was applied, was 8·016 knots, and with the casing 8·280 knots; and I find from experiments that I have made since, that if the casing had been made to come down level with the keel, and the stern made full as shown on this model, I have no doubt the speed would have been at least one knot more.

The advantage of casing over the screw as a protection to it, will be generally admitted both for ships of war and for merchant vessels. I do not think that screws in general get injured or broken unless they come in contact with some foreign substance, or the ship is pitching in a heavy sea; and no doubt many of the ships that have been lost and never heard of, as well as those that were known to be wrecked through the breaking of their propellers, would have been saved had their propellers been protected; and I have no doubt that the day will come when the Legislature will not allow ships to carry passengers unless they are propelled by two or more protected screws and separate engines.

Another great advantage which was observed in the "Bruiser" was the entire removal of the disagreeable vibration, as well as the saving of much wear and tear, caused by it to the ship and machinery. The application of the casing over the screw of the "Bruiser" entirely prevented the racing of the engines when in a heavy sea, the trouble and anxiety caused by which is known to every marine engineer, as well as the loss of speed from the screw losing its hold on the water.

In conclusion I would remark that any improvements that were to be made in screw-propulsion, were expected by engineers and shipbuilders to be made in the screw itself. A greater mistake could not have been made, for there has been no real improvement made in the screw when worked in open water since the alteration made twenty-five years ago in its form in contradistinction to the system of making the centre or boss as small as consistent with strength, and the blades narrower towards the root than at the extremity. The placing of the screw in a tunnel I find requires it to be made nearer to the old form

of a small boss, and blades wide at the extremities. The screw of the "Bruiser" had a large boss and blades narrow at the extremities, and a little more speed would have been obtained if the screw had been altered, but if this had been done in the "Bruiser" it could not have been proved whether the improvements were due to the alteration of the screw or to the casing.

There is one remarkable fact, that Mr. Watson, the chief engineer of the "Bruiser," noticed that when the ship was at sea in clear water, the water was forced back in a column from the casing for a considerable distance without any perceptible increase in its diameter. The same thing occurs with my models when the screw is only enclosed in a metal casing; but in the model with a full stern, which gives the best results by far, this does not occur, as the water delivered from the screw stops at the stern, merely agitating the water there; neither does the stern drop when going at full speed, which is the case in fine-sterned launches, which is entirely due to the screw drawing the water from under the stern.

I am now engaged in making some interesting experiments upon some improvements in screw-propulsion, and the proportions, &c., of screw ships. When they are completed, I shall feel great pleasure in communicating the results to this Institution, should the Committee desire it.

Diagram No. 1.—Represents the stern of Her Majesty's ship "Bruiser," as fitted with the casing over the propeller.

Diagram No. 2.—Shows the stern of Her Majesty's steam-pinnace, No. 22, with a casing over the screw, and fitted with apparatus for showing the pressure of water at different places behind the screw, and over the boat's side, which consisted of a 3-inch square plate attached to the lever as shown; the pressure was taken by a Salter's balance attached to the arm over the boat. The following table gives some of the results:—

Speed of boat about 6 *knots in each case.*

Pressure on plate, 9 square-inch area at A						5·7 lbs.	
"	"	"	"	"	B	7·7 "	
						Screw working.	Screw disconnected, Boat towed.
"	"	"	"	"	C	9 lbs.	7 lbs.
"	"	"	"	"	D	18 "	7·5 "
"	"	"	"	"	E	18 "	5¼ "
"	"	"	"	"	F	16·5 "	9 "
Revolutions of screw						240 "	120 "

		Launch moored.	Screw working.
——	C	—	
——	D	5 lbs.	
——	E	6 "	
——	F	—	
Revolutions		240	

About 70 per cent. more water passed through the casing when the launch was going, than when moored and the screw working.

Diagram No. 3.—Is a curve, showing the requisite supply of water

for screw-propeller and in casings, with various proportions of power, the extra supply being obtained by means of a funnel-mouth attached to the casing.

The launch (fig. 2) had a speed of six knots, at 240 revolutions a minute. When the screw was working, and the boat under way, the pressure at C was 9 lbs., at E and D 18 lbs., and at F 16·5 lbs. When the launch was towed at that same speed by another ship, the pressure at C was 7 lbs., at E 7·5 lbs., at D 5¼ lbs., at F 9 lbs. In each case the revolutions made with the screw disconnected were 120, exactly one half what it did when it was driven by the engines. I think that is a point that has never been studied in the screw propeller before, nor given to the public in any case. When the launch was moored and screw working, the pressure at D was 5 lbs., and at E 6 lbs. The engines were going at the speed of 240 revolutions. (The CHAIRMAN: Moored by the stern?) Moored by the stern. In trying my models, I made a valve to shut up the aperture that admitted the water to the screw entirely, and opened a valve to admit the water that was inside the ship, the water then went in here (*pointing*), and the screws going drew all the water out of the ship directly, propelling the ship just the same.

Captain J. C. WILSON, R.N.: Very much the turbine principle, applied direct.

Mr. GRIFFITHS: The screw is nothing but a rotary pump, when enclosed in a casing.

Mr. WILLIAM SMITH, C.E.: I should like to ask Mr. Griffiths how the results to which he referred square with those made by Mr. Froude? Mr. Froude had made a number of experiments on the difference of the strain on a supposed block by the power transmitted through the screw, propelling the vessel at a given speed, and her being towed, and also from her being moored astern. I think he made a very exhaustive series of experiments—the first of the kind ever made.

Mr. GRIFFITHS: In those experiments, the object was to ascertain the quantity of water the screw required to work it, with the object of gaining the best results.

Admiral SELWYN: I think if Mr. Quick[1] had been here, we ought all have congratulated him on the fact that has come before us, that one of the oldest experimenters on the screw has very nearly arrived at the conclusion that, to make a thoroughly efficient screw, it is requisite to bring it almost into the condition of a turbine, and, if that be so, it will aid us very much in considering the whole question. It is quite possible we might find the turbine placed in some way as Mr. Griffiths has got it, more effective in some ways than discharging at the side of the ship. It will certainly take less room. The point to which attention ought to be called, is that the experiments Mr. Griffiths has given us, seem, as yet, to be rather begun than finished. I think you promised us more experiments, and you supposed the best results would be attained from a still greater prolongation of the casing.

Mr. GRIFFITHS: I proved that the casing ought to be brought down so that no water goes in from the side; if the water goes in from the side, it is sucked away from the stern of the ship.

Admiral SELWYN: I have often had reason to remember the trials made, many years ago, in the thickening of the run of a vessel, which bore very much on the question of bringing the greatest quantity of water possible to the screw. The "Teazer," and one or two other vessels, were doubled under the run with planking, and it produced a most remarkable decrease. Every inch of planking put on to the run of the vessel decreased nearly a knot an hour of the useful result. It was equivalent to just what we had in some of the early armoured vessels. The "Meteor," and others, were square vessels, like square boxes, an imitation of the Emperor Louis Napoleon's first armour clad. The run did not exist at all. The three small screws with which they were propelled were stuck practically behind a square box, and, under these circumstances, it will not surprise engineers to hear that they showed very little efficiency indeed. Here there is a very great advantage also to be found in the fact that the screw will derive great protection

[1] Engineer, R.N., a paper by whom, "On a proposed Combination of Propellers for Ships of War," had been read previously.

from floating wreckage, which is one of the objections we have to it, looking forward to naval combats. Although I am an advocate of the most advanced means of propulsion, I do not neglect any means which will make those which we have either more efficient or less liable to damage. I am quite sure Mr. Griffiths' experiments, in this direction, will have a legitimate result. I am afraid the Legislature is scarcely likely to interfere so rapidly as he thinks; they have so much to do one way and another that they are very little likely to take so much care of passengers as Mr. Plimsoll would desire. I have often noticed, in those large ships of the Inman and Cunard lines, that there is a remarkable driving of the water away from the stern, and a disturbance of the water which ought not to take place, if the screw was thoroughly and efficiently doing its work. If Mr. Griffiths can do away with that in any manner, and give us less racing in any manner, I am quite sure every naval engineer will give him a cordial vote of thanks.

Mr. H. Bowlby Wilson: I have recently made a voyage in a ship that has a screw made to drop below the keel of the vessel—the ship "Britannia." The screw was working 16 feet below the bottom of the keel, and we made an exceedingly fine voyage; she performed remarkably well. But the ship has been taken off and something has been done to the screw, which seems to suggest that there must be some practical difficulty to be overcome. Perhaps Mr. Griffiths can throw a little light upon it. I should just like to sustain the observation made by Admiral Selwyn that the fineness of the run of a ship is just as important in the replacement of the water as the fine lines are in its displacement. I have taken considerable part in the discussions that have taken place in America on questions of this kind, and I have invariably found that my own experience and observations on the performance of vessels carries out exactly the fact as stated by Admiral Selwyn,—that in order that the screw shall work efficiently, it is necessary for the lines of the run to be equally fine with those of the entrance. I would remark in respect to the performance of the screw in the "Britannia," that I experienced a slight tremor all the time, which I imputed to the circumstance that it was not working in a horizontal position with the keel. There was a slight lifting motion. I went repeatedly to the extreme stern of the ship, and felt the shaking motion continually. We made one of the quickest voyages on record; our average speed was 16 knots per hour till we arrived at Queenstown, but we had this continual motion. I discussed the question with Captain Thompson, who declined to explain what his ideas were in respect to the difficulties, but he said they would be cured, and I hope they will be.

Captain Wilson: I think the gentleman who has just spoken has rather strengthened Mr. Griffiths' hands by what he has said. I think Mr. Griffiths does not propose to make any particular alteration in the run of the ship.

Mr. Griffiths: Oh, decidedly: making it full. I come to the old style of ship.

Captain Wilson: You draw your water from underneath, and I suppose the effect is very much the same. You simply confine the water by taking it from underneath the casing; therefore I suppose the results are very much the same, excepting that you give the ship more buoyancy about the stern by drawing the water from underneath, instead of taking it away from under the counter.

Mr. Griffiths: There is another point. If you do not make her with a big stern, the water is forced away from the screws in a line, and draws the other water with it; whereas, if the stern is full enough to take all the water that comes from the screw, it does not force the water back at all—it merely fills the place as fast as the ship goes along.

Captain Wilson: The weak point in all our armour-plated ships at present is that the screw is insufficiently protected, and in anything like a heavy sea they would be liable to damage from shot, even in engaging a wooden ship at long range. It would be a great advantage to be able to case in your screw, not only for speed, but for security. (Mr. Griffiths: It is perfectly secure.) It would not be so vulnerable in case of an attack, and would not be so liable in action to become fouled by floating wreck. You may remember that very curious little incident (I do not know whether it has ever been noticed in this Institution) which occurred in the German and French war, where we saw the advantages and disadvantages of masts and sails in war. In a little action which occurred off Havanna between a German and a French gunboat, the German gunboat lost her mizen-mast; the consequence was the wreckage fouled

her screw, and the screw was disabled. The Frenchman tried to run her on board, and as she came up close to her adversary she received a broadside, which cut her steam-pipe in two, and so was disabled. She immediately made sail, and escaped into neutral waters before the German had cleared her screw. If the German screw had been cased, she would have been able to have taken the Frenchman. We know that screws are very easily disabled, and we know the case of the "Alabama," where the "Kearsage" was successful in sinking her; that it was a mere chance that the "Kearsage" was not herself taken instead, as a shell from the "Alabama" was imbedded in her stern-post, and had it exploded it would have smashed her screw to pieces. If a shell can lodge in the stern-post of a ship, it might strike the screw and knock it to pieces too. Therefore I think it is of importance that the screws should be cased, in looking at it even from that point of view. As to whether it would add very much to the speed of a ship, Mr. Griffiths is a much better judge than most of us here present.

Commander C. F. W. JOHNSON, R.N.: Mr. Griffiths has claimed one advantage for his invention upon which I should like to ask him a question. He says, if he closes the aperture in the fore end of his casing in the event of a leak (provided, of course, there is some means of allowing the leakage to come to his screw), the water would be taken out of the ship by the screw, and the ship still propelled. Might not that advantage be influenced to a certain extent by the position of the leak? Take the case of the "Royal Albert," in the Mediterranean, during the Crimean War. The packing in her stern tube came loose, and she had to be run on shore to save the ship. Supposing such an accident as that to occur in a ship fitted with Mr. Griffiths' invention, would the advantage hold good; would the screw, under those circumstances, keep the water out of the ship?[1]

Mr. GRIFFITHS: I only tried it on the small model, which worked the water out and propelled the ship just the same; if there is depth enough of water in the ship to cover the aperture it will go right out directly, It must go out. It is nothing but a centrifugal pump when in a case, and it cannot help but take it out.

Commander JOHNSON: That would be a very valuable advantage; it is an accident which has frequently happened to screw ships, the packing of the stern tubing coming loose. In such a case the invention in itself would be a very great advantage.

Mr. GRIFFITHS: I think it is worth trying in some of our ships, since they run the risk of being run down. I think if the hole is only just the diameter of the screw, the screw would take off all the water working at full power; you have the full power of your engines pulling at it, and the speed of the ship keeps on all the same. It does not matter at all where the water comes from if you have an opening for it to go to the screw,—shut one opening and open the other.

Mr. SMITH: To do that I think you must be provided with another invention, that of shutters.

The CHAIRMAN: I think with respect to the "Royal Albert" nothing of the screw propeller's action would have answered in the absence of shutters. In fact, after the accident, she did steam as hard as she could into a little nook in the Archipelago, in the island of Zea, I think, and ran on shore on the beach, but even then the water had risen in spite of this supposed action of the screw, up to such a height, that it was quite time she was on shore to be safe. I can perfectly see that the collecting of water for the screw from beneath the bottom of a ship in motion is a very efficient way of getting more speed. Anybody who has looked over the stern of a ship merely passing through the water will see that things of medium weight

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[1] This question I asked, because it appeared to me that the force of the screw thus directed in the case of the "Royal Albert," and of the "Ajax" (of Holt's line) in the Shanghai river (and other cases similar to these) would *only* keep the water *out;* and failing a supply from forward, would *not* propel the ship. In the other case of a leak forward of the screw, the same force which would be pumping the water *out* of, would also appear to be pumping it *into* the ship.

It is also a grave question, whether the fires could be kept in under such circumstances, to move the engines.—C. J.

thrown overboard from the head, will invariably rise to the surface of the water at the rudder. The water to fill up the vacuum made by the ship while moving ahead, mostly comes from the bottom and not from the sides; on account of the increased pressure of the water from that depth it is more easy for it to rise up than to come from the sides. Therefore it is merely facilitating a good supply to take it by that casing. In this as in all things we must look at practical results. How is this casing to be secured to the ship's bottom so as to be free from accident and not be a source of danger in itself? It may involve difficulties which perhaps Mr. Griffiths has not contemplated, and which would be found in use, which we must make our minds up to, if we are to take up the invention. Whether we believe in all the details given by Mr. Griffiths or not, we must be very much obliged to him for the paper he has given us, and for the new ideas he has brought forward. There is a great deal of what is good in it, but I should hope to see it freed from the danger there might be in it. At any rate we all thank Mr. Griffiths for his paper.

Mr. GRIFFITHS: There is no occasion for casing at all; the ship can be built in an ordinary way with a hole underneath for the water to come in at. The casing is merely a temporary arrangement for ships now built. It does not follow that we want any casing whatever in new ships, but we should have the tunnel constructed within the ship, and nothing would be seen outside except the aperture for the discharged water from the screw.

LECTURE.

Friday, March 3rd, 1876.

Field Marshal H.R.H. the DUKE OF CAMBRIDGE, K.G., K.T., &c., &c., &c., &c., Commanding in Chief, President of the Institution, in the Chair.

CAVALRY.

By Major FRANK S. RUSSELL, 14th Hussars.

YOUR ROYAL HIGHNESS AND GENTLEMEN,

I HAVE been asked by the Council of this Institution, to give a lecture on "cavalry tactics," a subject which, however interesting to cavalry soldiers, would at first sight appear to be somewhat dry and uninteresting to the other arms of the profession and to the general public.

I think, Sir, however, that when we enter into the subject and analyse it, we shall find it of great importance and of special interest, more especially as up to the present time it has failed to receive that amount of attention which I feel it deserves.

From the date of the first improvements in rifled firearms down to the French and German war, there was an universal tendency throughout Europe, to decry cavalry and to declare that the time was gone for it again to play an important part in war. Strange to say this tendency to depreciate the arm, which above all others requires the most care and labour to bring it to perfection, has reappeared from time to time ever since armies first came into existence and has invariably been accompanied by a general decadence or falling off in the science of war. If we study the history of cavalry from its earliest days, we shall find that at every period of the world's history, when military art has attained any pitch of excellence, cavalry has invariably been much developed and has been most sedulously cultivated.

The history of the world is marked out in periods or eras, with each of which is associated the name of some chief or conqueror, who by superior ability, organization, or opportunities has handed down to posterity a great military reputation. Strange to say, the name of each one of those, almost without exception, is also associated with the special excellence of the cavalry he commanded. To begin from the

earliest times, Sesostris, the first great Egyptian monarch of whom we have any authentic record, who lived many ages before the Trojan war, and who may be said to have been at that period the greatest ruler of his day, is stated by all contemporary writers, both sacred and profane, to have been the founder of regular cavalry; and the prophet Isaiah mentions that the Egyptians were the best horsemen of the world. It is a curious circumstance that the first time light-cavalry is spoken of, it is with reference to a corps of Amazons mentioned by Herodotus, and of whom Hippocrates also speaks, explaining how he performed an operation on their breasts in order to enable them to use the bow and javelin.

After the decline of the Egyptian power, Philip and Alexander of Macedon may next be said to have been the most renowned conquerors who have left their mark on history, and both have been specially noted for the perfection to which they brought their cavalry, to whose excellence indeed they owed most of their victories. The exploits of Alexander's horsemen, more especially at the battle of Arbela (B.C. 331), may well serve as an example to us at the present day. Not only did they defeat their enemy on the battle-field, by brilliant flanking movements combined with sudden deployment, but they pursued him after defeat, 75 miles in 24 hours.

I fear, however, that my allotted time and your patience would alike fail me were I to enumerate the various great conquerors in history, who have also been distinguished cavalry leaders. It is, however, impossible to omit Hannibal in ancient, and Frederick the Great, in more modern times. Hannibal entirely owed his successes over the Romans to his cavalry; and of twenty-two pitched battles fought by Frederick and his generals, fifteen were decided by cavalry. Our own General Marlborough won his two greatest victories, Blenheim and Ramillies, by the timely and efficient action of his horsemen.

After the invention of gunpowder, there was the same tendency to decry cavalry as existed when the latest improvements were introduced into rifled fire-arms. I remember, when I first joined the army, an enthusiastic instructor of musketry proving to me, as he thought, conclusively, that if I ever attempted to attack infantry, I must inevitably be killed at least four times over before I could hope to reach them; and he explained that hence I had better exchange into some other more useful and less dangerous arm of the service. I have no doubt that the enthusiastic musketeer of the 16th century used the same arguments to the ponderous and slowly moving horseman of his time. Charles the Twelfth of Sweden, however, and Gustavus Adolphus soon demonstrated that the days of cavalry, so far from having gone, had scarcely arrived, and that then, as now, although their tactics must be altered to suit the requirements of the time, the importance of their mission remains the same. But as remarked by Captain Nolan, great and successful as were the achievements of the Swedish and French cavalry in the 17th century, they could in no way compare with the Turks who first showed Europe what might be done by cold steel, coupled with extraordinary rapidity of movement. It is a remarkable fact that the Turks obtained a more complete mastery over infantry than any other

cavalry have ever done. In fact the Russians habitually made use of *chevaux-de-frise* to protect themselves, and each battalion had two light carts attached to it in order to carry these obstacles. It was mainly the example of the Turks that first led European Commanders, and notably Frederick the Great, to adopt the only system of training and tactics that can ever render cavalry formidable in war. They shewed that the first requisite is to make a horseman master of his horse, and that unless cavalry are accustomed to move rapidly, they surrender all the advantages of being on horseback without having any of the benefits of being on foot.

After the death of Frederick the Great, it may be said that the sun of the cavalry service set and only rose for a short time and with diminished brightness in the days of Napoleon. That great conqueror, like every other great conqueror, owed many of his victories to the action of his cavalry both off and on the battle-field; he also, like Cæsar and Alexander, was checked in his career of victory by the want of cavalry; as he, himself, said at St. Helena, had he possessed cavalry after Lutzen and Bautzen, the 1813 campaign would then have been ended, neither Leipsic nor Waterloo would ever have been fought. Of the many losses that the Russian war entailed on him, the annihilation of his cavalry was the most serious. He appeared at the head of another army by next spring, but he could not re-create a force of cavalry in a few months, and to this may be traced all his subsequent misfortunes.

From the fall of Napoleon down to the present day, cavalry has in no way had that relative importance, or received that attention which it deserves. In the long peace this was not astonishing, and the wars that followed, from their character did not illustrate the mission of cavalry. The Crimean war was a siege, the Italian campaign of 1850 took place in a country peculiarly unsuited to mounted arms. We next come to the war of 1866, and here for the first time we find the cavalry-arm regaining that importance which it once possessed; but even then it cannot be said to have been used with full effect or brilliancy. As remarked by the author of the *Tactical Retrospect*, the Prussian cavalry was notoriously mismanaged. The Austrians were far more efficient both on the battle-field and off it. It is now proved that General Benedek had full information as to the movements of his enemies, and the way in which the Austrian retreat was covered after Koniggratz may well serve as a model for all cavalry leaders to the end of time.

The events of the late war are so recent that it seems unnecessary even to allude to them. We all know that the lessons learnt by the Prussians in 1866 were not thrown away. We all know that the admirable manner in which the duties of outposts and reconnoitring were performed, conduced more than any other cause to the success of the campaign. It seems that but little additional can now be learnt as to the employment of cavalry off the field of battle. All that is required is, to put in practice the rules and principles of bygone days, practised in the days of Frederick the Great; by our own cavalry in the Peninsula; by Napoleon in his earlier wars, as long as he had any cavalry worthy

the name, and now again revived, it is hoped never again to be forgotten.

It cannot, however, be said that we have in any way got to the bottom of the problem as to how cavalry may be best employed in action, or that the last war has done much to enlighten us. The history of the French cavalry in that campaign has proved to us now more than ever, that there is no quality in a cavalry Officer so fatal as bravery, unless it is tempered with discretion. We know how the magnificent regiments that in former days we used so justly to admire in Paris were absolutely annihilated within a few weeks of the declaration of war—not only annihilated but needlessly sacrificed—fruitlessly thrown away. Nothing could exceed the bravery of Bonnemain's Cuirassiers, who charged through the vineyards at Wörth, or of those Lancers, who being kept all day under fire, lost nearly half their Officers and men without even themselves coming into action. The charges of the Chasseurs d'Afrique down the slopes of Sedan, like our light cavalry charge at Balaclava, were lamentable examples of what brave men will do, but what they should never be asked to attempt.

I think no one can read the history of the French cavalry during the late war without feeling that ignorance, dangerous at all times, is doubly so in a cavalry leader. The responsibility of an infantry General is great when he comes into action, but of a cavalry General how much more! There is no time to correct an error, no time to consult or advise; in one short moment the training and study of years must be turned to account; in one short moment victory may be lost or won. And yet, Sir, I believe it has been said, that study of cavalry tactics is a waste of time, and labour thrown away. But although prudence and knowledge are, if possible, even more necessary in a cavalry leader than in any other, there must be also that dash and daring, which, although sometimes the accompaniment of age, is usually the attribute of youth. Seidlitz was made General of the Russian cavalry at the age of thirty. Lord Uxbridge was little over forty when he lost his leg at Waterloo. It has been remarked, and I think with great truth, that all the qualities which make a good man to hounds are those which are most valuable in a cavalry Officer. He must ride well; he must be bold and fearless; he must have a good eye and quick decision; but these qualities are even dangerous unless he also has discretion and knowledge, otherwise, like any one riding across country, he must sooner or later come to desperate grief.

It may be said, however, that we have complete examples how cavalry should *not* be used on the field of battle in the presence of breech-loaders, but have we learnt how it can be used? or whether it can be used at all? I think that in the next great European war we shall see a new phase of cavalry warfare. I dare say we all remember that last August some alarm was created throughout Europe by a report that Russia was mobilizing her cavalry. It turned out that mobilizing was the wrong word, it should have been re-organising, and that Russia was only following the example of the other great Powers, and was forming her cavalry into independent divisions along her frontier, so

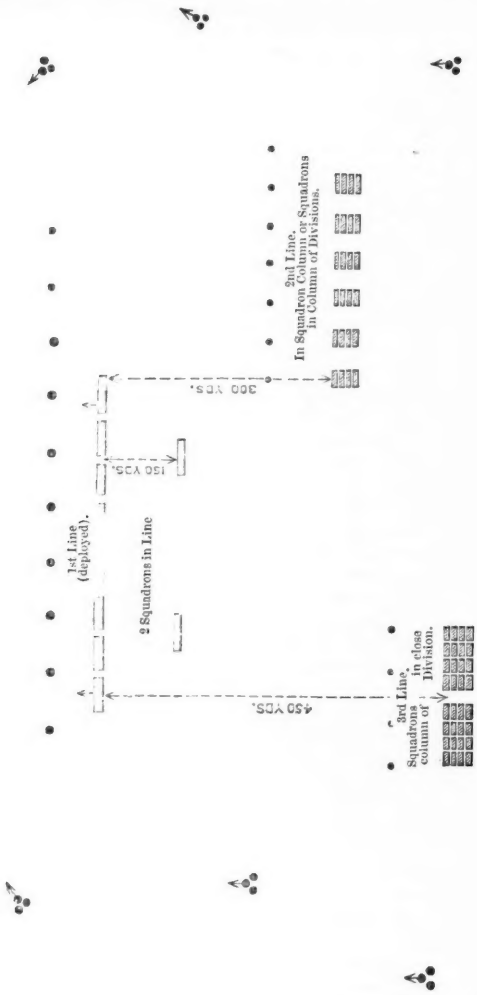
that it might be able to take the field within a few days of the declaration of war.

I venture, therefore, to make a prediction, of the truth of which I am fully satisfied, although I have not seen it suggested elsewhere, I say, that within a few days after the next European war is declared, we shall hear of a great cavalry battle, which will exercise not only a great moral, but also a great material influence on the ultimate fate of the campaign. The cavalry of each combatant will press on that of the other, each will attempt at one point to tear aside the curtain before it, and the result will be a great cavalry action. The General, whose horsemen prove victorious, will not only have the prestige of an early success, but will also have the inestimable advantage, by the acknowledged superiority of his cavalry, of being able to screen his own movements, and to penetrate those of his adversary. The same is true in the case of an English army—in any expedition that we are forced to send on the continent of Europe, our independent cavalry division would inevitably bear the first brunt of battle. Here some one may remark, that in our new mobilization-scheme no provision is made for independent cavalry divisions; to this it may be replied, that the scheme, as it stands, is intended for defensive purposes, but that if an English army ever took the field, cavalry divisions would be at once organised with transport and hospital service, entirely independent of the rest of the army.

It is now therefore more than ever necessary to study and practise handling masses of cavalry in combined action. Reconnoitring and outpost duty are important—more important than ever, but they are not everything, as some time since there was a tendency to imagine. Now more than ever must cavalry be practised in combined manœuvres—now more than ever must its leaders be accustomed to handle rapidly and efficiently large bodies united under their command. In England we labour under special disadvantages, whereas on the Continent there are many large spaces of ground where masses of cavalry can be manœuvred without difficulty; in this country we have no such facilities, except perhaps on the Wiltshire Downs, and there they can only be used occasionally. However, as we all know, Aldershot and the Curragh, every year during the drill season, the advantages we possess are turned to the fullest account.

It was my good fortune last year, after the conclusion of our manœuvres, to see the Prussian cavalry manœuvres at Walsröde, in Hanover, where three brigades were exercised in a united division. At these drills there was much that was interesting, but nothing remarkably new or original. A flank was invariably combined with a front attack; three lines were habitually used, sometimes there were more, but under no circumstances was any attack made with less than three lines. I need not remark that although for some time discontinued, this habit of manœuvring with three lines is of ancient date. The Duke of Wellington wrote a letter to Lord W. Russell, in 1833, in which he remarks that cavalry, "being only useful or even safe by the "employment of large reserves, it should never be manœuvred in "fewer than three lines." He also makes some observations as to the

use of the rank entire, to which I shall presently refer. This diagram shows the normal formations in which a German cavalry division of



Each line represents a brigade composed of two regiments with four squadrons each. The two squadrons in rear of the first line are taken from the second line, which, it will be observed is consequently composed of six squadrons instead of eight. The squadron is, as will be seen, composed of four divisions. The squadrons in the second line are supposed to have sufficient intervals for the deployment of their divisions.

three brigades, each brigade of two regiments, advances to the attack. It is the same as that in the last section of the German cavalry

regulations, translated by Captain Trench, 20th Hussars, and is also in General Walker's pamphlet, just published, on the "Tactics and Organization of Cavalry." The first line, as you see, is deployed and is usually composed of heavy cavalry, the theory being, that they will be most effective for the first shock, whereas the medium and light cavalry can move more quickly and hence are better for flank attacks. I think it unnecessary for me to go into the details of this formation or of its advantages, these are very fully laid down in the Prussian cavalry regulations referred to, and are ably discussed at considerable length in General Walker's pamphlet. I will only remark on one or two points, which seemed to me worthy of attention. The formation in columns of division is, I venture to think, an excellent one, less unwieldy than line and capable of being immediately converted into line, it affords peculiar facilities for advances over rough ground, and is I may say alike handy, compact, flexible. It can be wheeled to either flank without difficulty, and appears to admit of more uniform rapidity of movement when an oblique direction is required than is possible when formations in line or in broader columns are adhered to.

The introduction of division drill into our service, perhaps might be inexpedient, as it would necessitate an entire change in the organization of our regiments and in the strength of our squadrons, but from what I saw of its practical working, I cannot speak too highly of it, and the best proof of its usefulness is the uniform rapidity with which regiments moved; and this, although the German cavalry soldiers, as regards riding, cannot be compared with our own. The horses, although of excellent quality and well bred, appear much overworked and all are very low in condition. There is certainly one most important point, on which I think English Cavalry Officers may most justly congratulate themselves, and that is on the admirable stable management, on the care taken by the men of their horses throughout our entire service. In Germany, although no young or unseasoned horses are ever admitted into the ranks, as unfortunately is the case in our Army, and with squadrons usually above 130 and never less than 120 strong, I never saw more than 100 horses turned out, and very often far fewer. At the same time I cannot help expressing my regret, first, that our regiments and squadrons are so absurdly weak as compared to those of foreign Armies; and secondly, that the nominal strength, weak as it is, is practically far more than their effective strength. I cannot help regretting that we have not, like other nations, remount depôts, where our young horses can be trained and seasoned until they are fit to be placed in the ranks, and to take part in a campaign. Until this is done, the nominal strength of cavalry regiments is entirely a fictitious one. I venture also to think that it is neither fair to the horses themselves or to the men who ride them, to expect four-year-olds to gallop with 17 stone on their backs, or to do the work of aged horses.

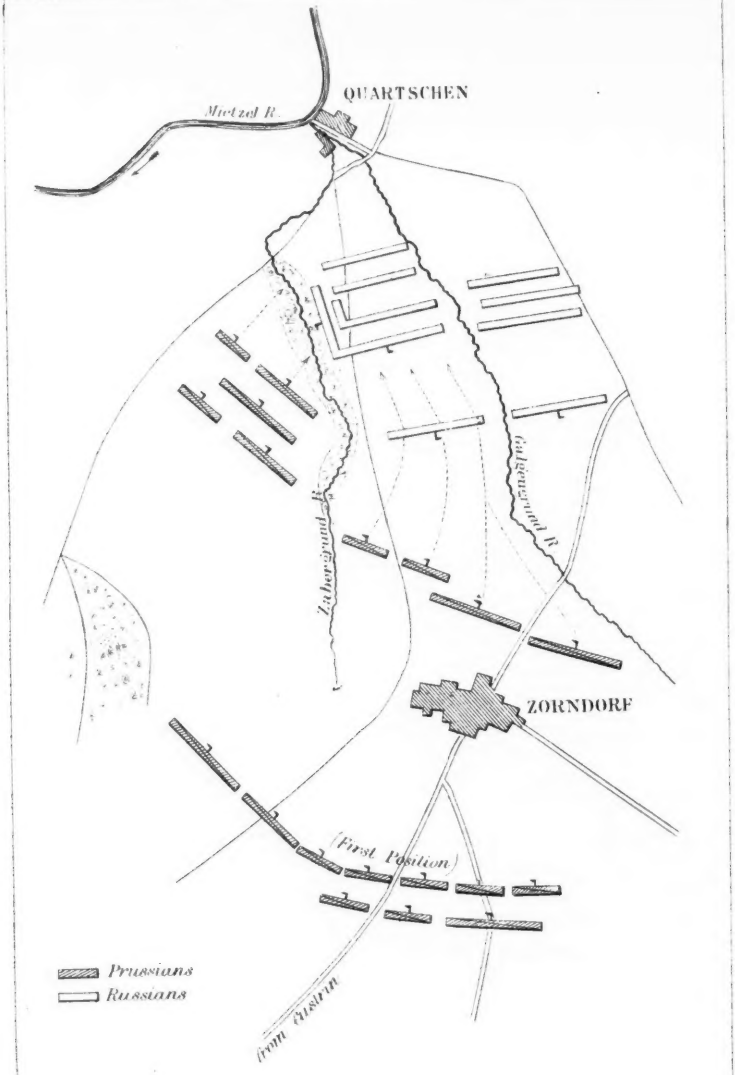
Before quitting the subject of the German cavalry, I would wish to mention their very excellent system of practising the *mêlée* or the disorder, which inevitably occurs in every regiment after almost every advance. Men, as it were, fall out, go through the motion of sword

exercise; then on a signal being given, rally behind their squadron leader, and move off as a squadron without being told off fresh. Thus an immense amount of time is saved, and men are accustomed to confusion without themselves becoming confused.

I have referred to the employment of cavalry in three or more lines with powerful reserves. I think that it may be interesting to give one historical illustration of the success which has followed the use of powerful reserves, and another of the disastrous results of neglecting them. I have selected the battle of Zorndorff as the first, and the battle of Waterloo as the second illustration.

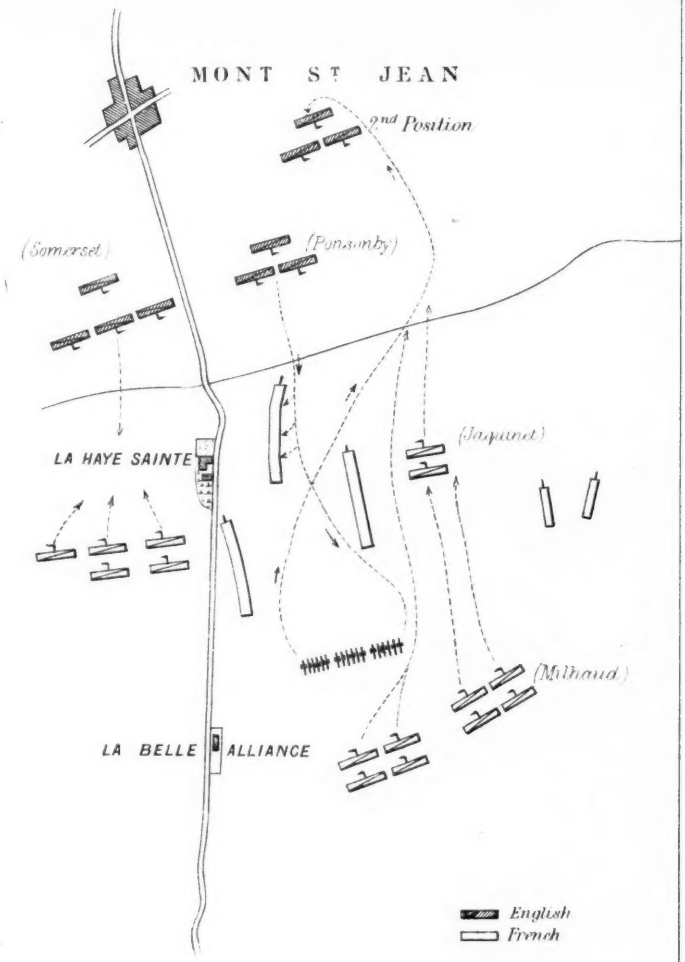
The battle of Zorndorff was fought on the 24th of August, 1758, between the Prussians under Frederick the Great, and the Russians under General Fermor. The former had about 22,000 infantry and 83 squadrons, or about 10,000 cavalry, in fact nearly one-third of the entire force. The Russians had 52,000 infantry, but only 51 squadrons of cavalry. It is not my intention to give an account of this battle, I only wish to notice the special action of the cavalry, which may be said to have been employed at two distinct and separate moments of the battle. The first is shown on the diagram, and resembles in some particulars of its details, but on a much larger scale, the charge of our heavy cavalry brigade at Balaclava, since the Russian cavalry remained stationary in column and awaited the attack of Seidlitz's squadrons, which enveloped them on all sides and finally routed them. You will see here an example of the use of three lines, also a flank combined with a front attack. The 31 squadrons on the left, under the immediate command of Seidlitz, were the reserve cavalry of the Army, the 25 squadrons shown on the plan, as in echelon on his right, were the cavalry of the left wing. Seidlitz had previously reconnoitred with the greatest care the ground in front of the enemy, and had stationed non-commissioned Officers to mark the places where the stream Zabergrund could be crossed. This enabled him, when the opportunity offered, at a very critical moment of the battle, to move with great rapidity across the stream, and to attack the flank of the enemy, while the other cavalry supported and attacked in front. I may mention in this, as in the last charge, which decided the fortunes of the day, that the cramped character of the ground made it necessary to form the lines one in rear of the other, instead of in echelon. In both instances the third line was composed of Hussars, who wheeled round, attacked the enemy in reverse, and completed the success gained by the other two.

In the final charge Seidlitz employed 61 squadrons, or more than 7,000 men. In the first line, were 18 squadrons of Cuirassiers, in the second, 15 squadrons of Dragoons, and in the third, 28 squadrons of Hussars, the distance between the lines being about 250 paces at the commencement. The first line had orders to charge home, to have as few intervals as possible, and neither to take prisoners nor guns. The second line had large squadron intervals closed up to within 100 yards of the first line, and was directed to confine itself to supporting it, filling up any gaps that might occur. The third and last line was directed to follow at 250 yards distance, and to take prisoners and guns. The great dust raised by the enormous force of cavalry prevented the Russian infantry,



CAVALRY ATTACK AT ZORNDORF 1758

J. Jobbins



CHARGE OF HEAVY CAVALRY AT WATERLOO.

J. Jobbins

who were already engaged in front, from distinguishing their movements. The Russian cavalry had already been nearly destroyed, and those that remained did not await the attack of Seidlitz's squadrons. The infantry, however, who were formed twelve deep and supported by 100 guns, remained steady and received the charge which utterly annihilated them, and from that moment the battle was won.

There are many points deserving of special remark connected with this battle were there time to notice them, which I fear there is not. I must, however, point out the great freedom of action which on this occasion was left to the cavalry commander; in point of fact, in the latter part of the day, Frederick the Great conformed the movements of his army to those of his cavalry leader. Seidlitz's success was entirely owing to his extraordinary quickness of perception, and to the great care with which he had reconnoitred the ground between him and the enemy. Zorndorff was one of the most deadly battles that has ever been fought. Of 32,000 men, the Prussians lost about 12,000 killed and wounded; of about 60,000, the Russians about 21,000. Probably cavalry will never again play so important a part in any general action.

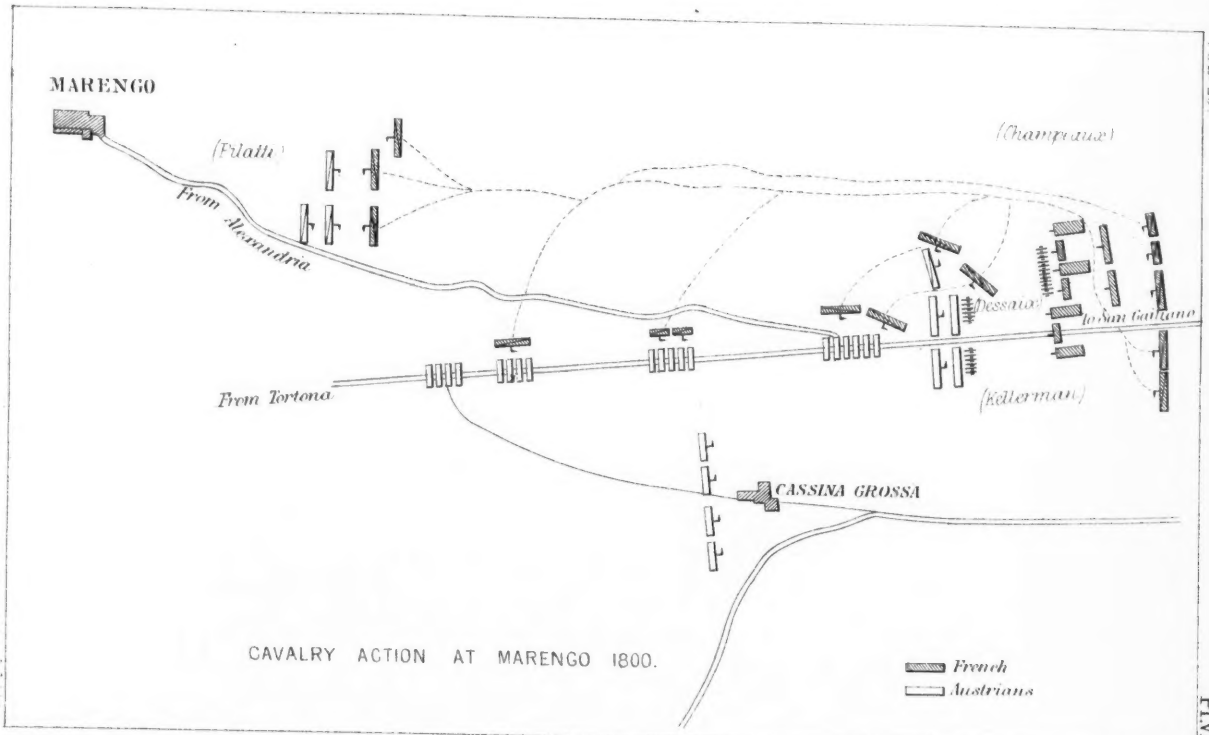
We now come to the battle of Waterloo, to illustrate, as I said before, the fatal consequences of neglecting the use of reserves. At a very critical period of the action, the Earl of Uxbridge, the Commander-in-Chief of the British Cavalry, with the true inspiration of a cavalry leader, perceived that an opportunity had arrived for striking a decisive blow, so he ordered Lord Edward Somerset on the right, to charge with the 1st and 2nd Life Guards and King's Dragoon Guards, keeping the Blues in reserve, while Ponsonby was to charge on the left with the Royals and Enniskillen Dragoons, having the Greys in reserve. He had previously told the Officers commanding the other cavalry brigades not to wait for orders, but to use their own discretion and to support any attack that might be made. The charge of both the heavy brigades was most marvellously successful. Somerset overthrew the cuirassiers opposed to him, while Ponsonby attacked a column of French infantry and annihilated it, then galloped on, attacked and captured forty guns. As Alison remarks, the achievement was unparalleled, two French columns 5,000 strong were completely destroyed, forty guns were rendered useless. But unhappily the light brigades had not supported, and the supporting regiments of the brigades themselves, carried away by their enthusiasm, had come into first line, when in the moment of victory, with their horses blown, they were attacked on the flank by French Lancers. The Union Brigade which had gone into action 1,100 strong was reduced to a single squadron, and the two brigades who had numbered 2,300 sabres could scarcely muster 200.

I have already spoken of the employment of cavalry when opposed to other cavalry, or when used on the flanks of an army; and I have endeavoured to shew that we cannot afford now, any more than in former days, to neglect the training of either Officers or men to act in large bodies. Cavalry manœuvres on an extended scale are now more than ever necessary. Great, however, as the mission of cavalry still

is, I think we must all acknowledge that it is no longer possible to use it in the manner of the first Napoleon.

Huge masses of cuirassiers can no longer hope to break through the centre of an army, or to have any success against unbroken or undemoralized infantry. It seems to me that the failure of the French cavalry leaders to recognise this axiom, was the cause of the disastrous mistakes they committed in the late war. I am, however, nevertheless, fully convinced that moments must come, and always will come in every great battle, when comparatively small bodies of horsemen may still be used decisively and effectually against both infantry and guns. The tendency of all troops armed with the breech-loader, and trained according to the newest methods of tactics, is to waste their ammunition, to scatter and to disperse. Almost inevitably, times must occur at the end of an action when bodies of infantry, fighting in loose order in the confusion and smoke of an action, wander away from supports, when ammunition is exhausted, when gaps occur in the line of battle, when guns find themselves unprotected, when in fact a charge of cavalry, if quick and decided, must produce a crushing effect. But as the opportunities for its action are now far fewer, as the consequences of a mistake are now far more disastrous than in former days, now more than ever does success depend on the ability of a leader.

I think I cannot do better than illustrate what I mean by the battle of Marengo, which is an admirable example of the manner in which the tide of victory may be turned by a small body of cavalry properly led. This action was fought on the 14th June, 1800, between about 28,000 French under Napoleon, then General Bonaparte, and about 30,000 Austrians under Mélas. Of these respective forces, the French had about 3,000 and the Austrians about 7,000 cavalry. I will not attempt to give an account of the battle, but suffice it to say that at about two o'clock in the afternoon, the Austrians had obtained so decided a success, while the French were in such complete and disordered retreat, that General Mélas with his staff thought the battle won and retired to Alexandria, the Quartermaster-General Zach being directed to carry out the pursuit. The French retreated in the direction of San Guiliano, and were pursued along that road by the Austrian infantry in column of route, while flanking parties were sent out on both sides, the main body of the Austrian cavalry being on the right. A last attempt, however, was made by Bonaparte to retrieve the fortunes of the day. He brought up Dessaix's infantry division, placed it across the road, and then directed Kellerman with a portion of his cavalry to pass from the left to the right flank between the two lines of infantry, and to attack the left of the Austrian columns as they were on the line of march. The manœuvre was perfectly successful. Kellerman first overthrew a regiment of dragoons that opposed him, then fell on and destroyed the Austrian's columns one after another as they were attempting to deploy. A complete route was thus suddenly converted into a victory, and on the following day the twelve principal fortresses were handed over to Bonaparte, and he became master of Italy. In fact, less than 700 horsemen changed the map of Europe.


MARENGO
(Victor)
From Alexandria
(Champeaux)
Pessaux
to San Giuliano
From Tortona
(Kellerman)
CASSINA GROSSA
CAVALRY ACTION AT MARENGO 1800.
French
Austrians

PLATE

I think that it would be impossible to find a more striking example of the effect that may be produced by a timely charge of a very small body of cavalry on surprised and unprepared infantry. Timely, I may say it was, since Marmont, who witnessed it, declared that had it been delivered five minutes sooner or five minutes later it would have proved unavailing.

There are connected with the cavalry service one or two abstract questions to which, Sir, I should wish, if possible, to refer. A short time since the formation of a corps of mounted riflemen was strongly urged by some great and experienced military authorities. I may remark that the idea is not new, nor has the experiment been untried. So long ago as the Seven Years' War the Hungarians organized several corps of mounted infantry; as we all know, in the American Civil War, the so-called cavalry were as a rule little more than infantry on horseback, partly because the nature of the country was wholly unsuited for cavalry proper, and partly because there was neither the time nor the opportunity to give men that training which true cavalry soldiers require. Great, however, as the advantages undoubtedly are of being able to move riflemen rapidly from point to point, I cannot but think it would be most undesirable either to convert any portion of our small and insufficient body of cavalry into the hybrid animals described, or to create any new arm answering to that description. It would seem that every sixpence, which the country will consent to spend on our cavalry, should be devoted to increasing the strength of our skeleton regiments, to making them truly effective, and to creating reserves. I also see no reason whatever why cavalry soldiers proper should not be drilled and accustomed to perform all the manœuvres of infantry, nor can I conceive why their power to manœuvre on foot should in any way impair their efficiency on horseback. The cavalry of Seidlitz, which achieved so many and such great successes, was habitually and most carefully trained to act on foot; and in the late war, there are many instances when dismounted cavalry performed excellent service.

There is, however, one thing specially necessary if horsemen are to be thus employed, that is, that they should be armed with a weapon equal in every respect to that which they will meet. It is scarcely fair to ask cavalry armed with carbines that shoot indifferently at 500 yards to engage infantry armed with rifles that shoot well at 1,500. I may mention that the Prussian cavalry are armed with adapted Chassepôts and the Mauser cartridge. The arm is sighted up to 1,200 metres, and shoots admirably up to 800. I also venture to think that it is a subject worthy of consideration whether we should not follow the example of the Germans, and arm with rifles a certain proportion in every squadron of Lancers.

There is another point, also, to which I should wish to call attention. The invention of gunpowder and the improvement in fire-arms have caused a diminution in the depth of formations. Formerly infantry, and even cavalry, fought six deep. This formation was reduced to two deep, some nations, notoriously the Prussians, adhering until quite recently to their three deep formation. The British infantry were almost the first to fight two deep, being from their quality able

to maintain a shallower formation than other nations. Now practically the infantry of all European nations fight in single rank, with wide intervals. I am unable to understand why the same principle, in a modified form, has not been applied to cavalry. It appears to me that the only use of the rear rank is, first, to fill up gaps in the front rank, secondly, to tumble over the front rank, and, lastly, to receive the benefit of all the shot and shell intended for the front rank. Why, therefore, not reduce the strength of the rear rank to one-third or one-fourth, which would suffice to fill up gaps without entailing unnecessary loss? I have now before me letters from the late Duke of Wellington and from Sir Hussey Vivian, expressing opinions more or less favourable to the use of rank-entire. General Bacon, who commanded the cavalry of the English Legion in Spain, habitually practised it, and found it answer so well, that he was the principal advocate for its adoption. The arguments that have been used for and against this rank-entire are numerous and varied; but into these, I fear, there is now scarcely time to enter. I can only say that as the use of rank-entire is habitually practised in the Prussian and in other foreign armies, it would seem not unadvisable to practise it in ours, more especially as thereby division-drill might be tried without introducing a change in organization.

I would, lastly, wish to speak of cavalry pioneers. This subject has, I believe, already received attention, and I hear that the Committee appointed to report on it, have strongly recommended their adoption. I have lately seen a most interesting account of the organization of cavalry pioneers in the Austrian Army, and the arguments which may be used for their introduction into our service are, I think, most strong and convincing. The cavalry in advance of an army will at all times have to perform duties where pioneers or engineers are required. They will have to destroy and repair railroads, to blow up bridges, to erect and remove obstacles, to create drinking-places for the horses, and, in fact, to perform various works of that description too numerous to mention. I may notice that, in this particular, as well as in some others, the Austrian seems to be considerably in advance of the Prussian cavalry. In the latter service, there are no cavalry pioneers, but all the non-commissioned officers and older soldiers are practised in the destruction and repair of railroads. They also carry a dynamite cartridge, which destroys a rail in three minutes; each squadron also carries an apparatus for clinking up the telegraph posts and cutting the wires, also a silver thread for joining them. At the present time, it is the custom in our Army to attach mounted engineers to cavalry with a view to their carrying out these duties. It would seem, however, that the objections to this system are self-evident, and that it is desirable in every way to have the cavalry in advance of an army, dependent only on its own resources, in fact, able to move at the shortest notice wherever it may be required.

As my limits of time are already nearly exceeded, I must only venture to say a very few words in conclusion. I am far from being one of those who pretend to think the British Army is going to the dogs, or that it would fight a bit less brilliantly now than it always

has done; but I must say that there is one point on which I, in company, I am sure, with every other cavalry Officer, feel great disquietude. We regret to see the small force of cavalry we possess, but we regret still more the impossibility of replacing it, and not only of replacing it, but even of filling up the gaps which the first fortnight of a campaign would cause in the ranks. Half-drilled men, if their heart is in the right place, are valuable when incorporated with drilled and experienced soldiers of an infantry battalion. But in cavalry it is very different. So far from being useful, untrained men and horses are absolutely dangerous. They throw everything into disorder, and, like Von Hake's Hussars at Waterloo, are worse than useless.

Nevertheless, although more than five years have now passed away since the re-organization of the English Army was commenced, we have not yet seen any signs of cavalry reserves either of men or of horses. Our small force of cavalry once gone, disabled, or decimated, could not be replaced. Our armies might win brilliant victories, but their fruits could not be gathered. I am sure that all here present will join with me in expressing an earnest hope that the day may not be far distant when this omission may be repaired.

The CHAIRMAN: Gentlemen, I am sure that we are much indebted to the lecturer for calling our attention to this important subject. Of course, I am perfectly aware that in the opinion of the many cavalry Officers who are sitting around me, there is no subject that can require more consideration at this moment than that of the cavalry service. But circumstances have so changed that what might have been very well in former days, I do not think would be quite so suited to the present day. As regards mounted cavalry in our service, that of course is a matter of £ s. d.; but I am afraid it would require a good deal to induce the public to think it absolutely necessary largely to increase the Estimates in order to have a much larger body of cavalry. All I can say is, if it is thought necessary, I for one should be very glad to know that we had a larger body, but it must be perfectly understood that it is a very expensive element, and will largely increase the War Estimates. Then as to the difficulty about horses: no one objects so much as I do, to see young horses too early backed, but as a matter of expenditure, if you have large depôts, you must pay for them, and as we have very small establishments, it is essential that every available horse should be in the ranks. There can be no two opinions that it is a better thing to back a horse, and get out of him what you can, than to keep him idle, and add to the expenses during the time he is so kept. That is the great difficulty we have to contend with. As regards the question of three lines, I cannot suppose that there can be two opinions upon that subject. All cavalry, like every other form of arm, must be well supported. The great fault has been of late years that we have extended our lines a great deal more than has been prudent. It is the natural impulse to extend, wherever there is a great latitude for action; but I think there can be no doubt that unless it be an extended line, well supported by reserves, either of infantry or of cavalry, but particularly of cavalry, it is a very unfavourable formation. I remember well frequently talking this question over with my late gallant friend, Sir Hope Grant, and Sir Hope Grant said to me over and over again that even a squadron of cavalry ought always to be divided, and to have a support; no portion of a squadron should be sent to the front without a support. If you adopt that principle, you extend it according to the numbers you have in command. There is a peculiarity about the Prussian system, which no doubt is also very valuable. I do not think it was alluded to to-day. I believe that in all these three-line formations care is always taken that the second line is thrown forward, or that whatever flank it is on, it always throws that flank forward, so that you make the flank-movement immediately upon the front attack; and that, of course, is a very important thing, because if the

front attack has taken effect, a certain amount of disorganization results, and a flank movement on a disorganized body is, of course, of the greatest possible importance. And that, I believe, is one of the new features, and one of the most important features of the present system in the Prussian service.

As regards the question of cavalry never manœuvring together in large bodies, I think that is doubtful. I apprehend that there are many occasions when you must sacrifice troops for the good of the whole, and on those occasions I have no doubt the cavalry must take its share of being sacrificed as well as any other branch of the service; but beyond that, I do not think any large body of cavalry would ever be sent to the front against the fire-arms of the present day, because they are so destructive that really at the end of any distance it is impossible to assume that many men or horses would be in a condition fairly and strongly to carry out a direct charge. But, that being so, I do not think it at all militates against the necessity for cavalry; on the contrary, I think it is one of the greatest mistakes—though I am happy to say it is now becoming exploded—to say that the day of cavalry has gone by. I think the day of cavalry has not at all gone by; on the contrary, an army without cavalry would do nothing at all now. Everything must be done so quickly,—advances, flank movements, and every other movement are made so quickly that unless you have large bodies of cavalry well to the front, at considerable distances, and almost unsupported by infantry, you do not know what is going on; the great object, therefore, nowadays must be to pay the greatest personal attention to reconnoitring and outpost duty. On those points I think we, perhaps, have been hitherto rather backward, but it is very natural. It is impossible to study a subject of that sort unless you have the opportunity of doing so at manœuvres. The difficulty that we have to contend with in manœuvres in this country is something very great. There is no doubt that of late we have had greater facilities than we had formerly; at the same time we have our country so intersected, and there is so much real damage done (unless the greatest care is taken) that we cannot expect to be able to go over private property without great objections being raised. I must say that the greatest liberality has been shown us upon the various occasions on which we have had manœuvres, but still there is always a great indisposition to make use of private property, and that makes all our movements extremely difficult. We must, therefore, imagine a great deal, and theorise a great deal more than is good on these occasions, because, depend upon it, theory is all very well, but practice is a great deal better. To show the value of cavalry on these occasions, I need only point out that it is not only the superior Officers who ought to show great ability, but the youngest Officer may be sent to the front with a few men, and any information he may gain, or any intelligence he may show, may save a whole army, or may be the means of gaining a great victory. Therefore it depends upon the individual Officer, from the highest to the lowest; and I really believe whilst every Officer should be well instructed, no portion of the service should have a quicker apprehension and appreciation of country than the cavalry officer. I believe, so far from looking down in any way on the cavalry, the cavalry soldier—and Officer especially—should have the greatest possible military acquirements. Amongst other things, sketching is of the greatest importance. I do not believe that any of our Officers ever dreamt of such a thing formerly, not because they would not have done it if called upon, but because they were not called upon. Now we have changed all that, and great attention is paid to the subject of sketching, and I am satisfied that the more those subjects are attended to, the better will be the position of our cavalry. I have ventured to throw out these few observations on this occasion because I do not like to leave this Institution without showing that I have taken some interest in the invaluable remarks made here on the part of the lecturer, and in the subject with which we had to deal. On this occasion we have to thank him for having brought the subject so prominently and ably before us. I understand it is wished that there should be some discussion about it. You will perceive in my position it would be better I should retire and leave the discussion free and unbiassed by not being present, and I therefore hope my leaving you now will not be considered as at all an indication that I do not take the greatest interest in hearing what may be said; but I think, under the circumstances, it would be more acceptable to you that you should have perfect freedom of discussion. Under these circumstances I believe General Shute will take the chair.

His Royal Highness having retired, General Shute, C.B., M.P., took the chair.

No Officer rising to commence the discussion, General Shute said: I am sorry that no Officer seems inclined to rise to make any observations on the lecture we have just heard. Perhaps if I venture to make a few remarks myself it may start a discussion on this important subject. First, then, with reference to the proposed re-mount depôts, I confess, from a considerable experience in India, and from what I have seen of the cavalry of other nations, as well as our own, I am inclined to think the practice of Commanding Officers buying the young horses for their regiments, as they do in England, and being responsible not only for their purchase but for their after improvement, has very great merits. I am sure the gallant lecturer will agree with me that there is no cavalry so mounted as the English, except perhaps cavalry of the Russian guard, which consists only of about ten thousand, which, as compared with their army, is small; and with regard to the instruction of the cavalry soldier, I am no great advocate for mounted rifles, because I am perfectly certain that cavalry soldiers should be so thoroughly instructed in dismounted service and the use of their rifles as to render such a force unnecessary. With reference to a cavalry reserve, I myself suggested last year to the Secretary of State for War—partly with a view to a slight increase of the cavalry, but still more in order that cavalry regiments might be less inconvenienced and delayed when a complete corps, squadron, or troop is suddenly ordered out in aid of the civil power, or any other emergency, by having to make arrangements for mounting old soldiers employed to break young horses, or formed troopers, handing over four-year-olds to the temporary care of recruits, making arrangements for drill sergeants, drill corporals, rough-riders, &c., to be left in the barracks—that there should be in every regiment a ninth troop, to be what the French would call an "out of the rank troop," containing all drill and riding instructors, young horses, with a proportion of *competent* though old or married soldiers who have nearly completed their services, to break them, and a proportion of old horses considered fit for little more than riding-school work for drilling recruits. The band and tradesmen should also be attached to this troop.

From this reserve troop, as I should call it, young soldiers and young horses would be drafted into the service squadrons as they were fit for regimental field days or general duty.

But some cavalry subalterns said: "Well, but General, but supposing I were promoted to a captaincy, do you think I should like to have this troop?" Of course not, but what I proposed was this: that it should be specially kept under a business man, say, receiving 2*s.* 6*d.* a-day extra, and that the subaltern in the same way should be paid extra. And I think it would be an admirable opportunity in these days, when purchase is gone and there is nothing for a man to look to who is promoted from the ranks, that he should have an opportunity of having the command of that troop, and bringing it on, understanding that he was rarely to leave barracks or go on leave. My idea was, that having that troop, it would form a depôt on all occasions. On this system your four squadrons could be ready, whether to go to a European war, to march to a manœuvre, or to aid the civil power, without any hindrance. That would be done with little expense, I hold with economy to the country, and would in some way fall in with the lecturer's idea of a depôt, because I maintain that our cavalry should always be prepared for war. What do we do now? We send three squadrons into the field instead of four, which is the proper organization, and form one squadron into a depôt, whereas a troop answers every purpose. And I maintain that for war, three squadrons is a false organization, because a cavalry regiment should be divisible, and a wing (two squadrons) under a field officer should be as effective as a weak regiment. As regards mounted rifles, the difficulty is this: I am perfectly certain that all who have had experience in the Crimea know, that the greatest essential is a knowledge of, and care of horses. The mounted soldier should feel that his primary arm and first care must be his horse. You cannot, therefore, give the horses too much care, and mounted infantry would not feel this; and I think if you had what you call mounted rifles, they would rather consider their horses of secondary consequence, and the result would be that after a few weeks of a campaign they would be dismounted. The cavalry soldier ought to have a good rifle. Length of barrel is not necessary to length of range, and there is no reason on earth why the cavalry soldier should not have a rifle ranging up to 1,000 yards, and I

think many infantry Officers present will agree with me; you do not often want more than that. I was on the Yeomanry Committee last year, and we strongly recommended that the Yeomanry should be practised in dismounted service. We know there is no sort of difficulty in training men to dismounted service. With regard to the Lancers, I am very prone to think that with our very weak proportion of cavalry, our Lancer regiments would be more valuable with rifles than with lances.

With regard to telegraphs, I have suggested long ago that every cavalry non-commissioned Officer should be taught to use the electric telegraph. There was, of course, a difficulty when the telegraphs were not in the hands of the Government, but now you may in every out-post and out-quarter, where the cavalry soldier has less to do than at head-quarters, get permission to have some of your non-commissioned Officers taught. So with regard to the destruction of railways, though I should hardly go in for the destruction of stone bridges, still they should be able to destroy the line and render roads and fords impassable, though I do not say they should go so far as to be instructed to make bridges for the passage of other troops following them, as some have suggested, because cavalry have other duties to perform that will not admit of such delays.

With regard to attack by cavalry, I am perfectly certain that we all admit that it is an arm of opportunity, and that the greater the extension of the troops, the more frequently will opportunities be found by a dashing good cavalry officer. In fact, I think we have opportunities now in warfare which cavalry never had before.

In the Prussian system, as the lecturer says, no opportunity is lost by cavalry of flank attack. No front attack should ever be made without an oblique attack on the enemy's flank if possible. Even the first line should have a squadron in rear of each of its flanks to protect its flank from a similar rear attack, and to dash forward and take the enemy in flank. I am only sorry I have not been able to take notes of the very valuable remarks of the gallant lecturer, every one of which I should most heartily endorse. I only hope I may yet have an opportunity in the House of Commons of pressing an augmentation of the cavalry. My own idea would be to have double the number of men in every cavalry regiment that there are horses. You may buy horses in case of sudden war, but you cannot buy ready-made dragoons. There are horses enough in every regiment to instruct double the number of men, and an inspecting General should see one-half mounted on one field-day and the other half on the next. I do not think this would necessarily entail any great expense.

Major RUSSELL: It appears to me that the great argument in favour of having re-mount depôts for young horses is the fact that thereby the nominal strength of our cavalry regiments would nearly coincide with their effective strength. At the present time, cavalry regiments at home, on what is called the foreign establishment, have a nominal strength of 606 men and 384 troop horses, and yet I discovered yesterday at Aldershot that the greatest strength on record ever turned out by any regiment was 318 troop horses, and this on the occasion of the review before the Emperor of Russia, when many horses were placed in the ranks that were unfit to take the field. The average strength of a strong regiment is from 290 to 300, and weak regiments, which have a nominal strength of 302 troop horses, rarely can turn out more than 230, if so many. As a point of fact we have now in England a very much smaller force of cavalry than appears on paper, as every regiment has 60 or 70 young horses that are quite unfit to undergo the fatigues of a week's campaign. In Germany no young horses appear on the establishment of a regiment until they are fit to take the field.

General SHUTE: I am really extremely sorry that we have not had the advantage of further observations, but the real fact is, all that has been discussed by the able lecturer is so utterly impossible of contradiction that there is no room for discussion. I now beg on your behalf to present our cordial thanks to Major Russell for his most instructive and interesting lecture.

Evening Meeting.

Monday, March 20th, 1876.

COLONEL LORD EUSTACE B. H. GASCOYNE-CECIL, M.P., Surveyor-General of the Ordnance, in the Chair.

NAMES OF MEMBERS who joined the Institution between the 31st January and 20th March, 1876.

LIFE.

Montgomery, R. A., Lieut. R.A.
Fincham, Herbert G., Assist. Commissary.
Wilson, J., Colonel Madras Staff Corps.
Daniell, W. H. M., Lieut. R.N.
Godfrey, Henry J., Lieut. R.N.
Woof, Richard, F.S.A., F.R.S.L., Lieut. late Worcestershire R.V.
Oxley, Charles L., Commander R.N.
Rennie, Geo. B., late Midshipman R.N.
McNeill, J. C., V.C., C.B., C.M.G., Colonel h.p. 47th Regt.

ANNUAL.

Brackenbury, H., Major late Depôt Batt.
Burroughs, C. de P., Lieut. 82nd Regt.
Arbuthnot, George, Lieut. 2nd R.N.B. Dragoons.
Henniker-Major, Hon. A. H., Lieut. Colds. Guards.
Golding, Henry, Captain h.p. 69th Regt.
Torrens, J. A. W. O. N., Lieut. 2nd R.N.B. Dragoons.
Foster, Kingsley O., Capt. The King's Own 1st Stafford Mil.
Biddlecombe, Sir George, Kt., C.B., Captain R.N.
Willan, L. P., Commander R.N.
Courtney, D. C., Lieut. R.E.
Twemlow, Fran. R., Lieut. 3rd Stafford Mil.
Pardoe, T. F., Captain 22nd Regiment.
Norcock, W. J., Lieut. R.N.
Crozier, H. E., Captain R.N.
Hamilton, I. J., Capt. 8th King's Regt.
Broome, C. S., Lieut. R.N.
Butler, J. B., Captain R.N.
Maude, F. N., Lieut. R.E.
Onslow, Geo. M., Captain 20th Hussars.
Radcliffe, R. P., Colonel R.A.
Sparks, E. T. B., Lieut. 98th Regiment.
Wise, Augt., Captain 2nd Warwick Mil.
Scott-Douglas, J. H., Lieut. 21st Rl. N.B. Fusiliers.
Young, S. S., Major 39th Middx. Rifle Volunteers.
Newall, D. J. F., Colonel R.A.
Bartholomew, Robt., Lieut. Wigton Mil.
Plunkett, R. H. W., Lieut. R.H.A.
Smith, Edward, Capt. 40th Middx. Rifle Volunteers.
Newington, Cecil G. H., Lieut. 31st Regiment.
Thompson, J. C., Capt. 26th Middx. Rifle Volunteers.
Gibbs, J. R., Lieut. 6th Regiment.

SOME SPECIAL FEATURES IN LARGE AND SMALL GRAIN POWDERS.

By Major J. P. MORGAN, R.A., Assistant-Superintendent Royal Gunpowder Factory, Waltham Abbey.

THIS is now the seventh time that I have had the honour of reading a paper in the theatre of this Institution; but I have never before received such distinguished encouragement as on this occasion. I trust my perseverance will induce some others to bring forward the results of their special studies for the general benefit of the Services. It is

also the third time that I have read a paper on the subject of gunpowder. The first was on the determination of its explosive force, without an accurate knowledge of which no scientific progress can be made in its manufacture. The second showed the difficulties which had been encountered, and the success which had been achieved in the manufacture of pebble powder. In the present paper, assuming the conditions on which the thorough ignition of a charge mainly depends, I intend to show how great an approximation there is to these conditions in the special features which regulate the burning of the individual grains of powder themselves, and how this depends not only on the size of the grains, but also on the facility with which the flame can penetrate towards the centre of the grain, and on the rate of burning of the particles of charcoal of which it is partly composed.

It is not many years since two sorts of powder only were sufficient for nearly every requirement of the Service, viz., Large Grain or L.G., for guns, and Fine Grain or F.G., for small arms. Both of these powders were manufactured in the same manner from the same description of charcoal, viz., alder or willow, differing from each other only in the sizes of the grain, L.G. being sifted between meshes of 8 and 16 to the inch, and F.G. between those of 16 and 36.

On the introduction of rifled small arms, F.G. was found unsuitable, and the first and most important alteration was the substitution of dogwood for alder, or willow charcoal. This necessitated the entire separation of the manufacture of small arm powder from that of powder for guns. The first powder of this description was made in 1859, and was of a size 16- to 24-mesh. It was known as Enfield Rifle, or E.R. powder. In 1860, the size of grain was increased to a 12- to 20-mesh, and the powder was called J. 2 until 1865, when the name was changed to Rifle Fine Grain or R.F.G. These dogwood powders can be distinguished from the old F.G., not only by the size of the grain, but more readily by the charcoal being browner and the grain being rounder and not so flakey. The inner portion of dogwood is of a reddish brown colour, and this colour is imparted to the charcoal and thus to the powder. The roundness of the grain is due to the soft friable nature of the charcoal, dogwood being a small soft wood and easily charred.

It has always been found that powders made from dogwood are more violent than those made from alder or willow. Some have thought that this is due to the larger proportion of gaseous matter in the constitution of dogwood charcoal, as exemplified in the following analyses, taken from the late Captain Smith's "Handbook of the Manufacture and Proof of Gunpowder."

	Ash.	Carbon.	Hydrogen.	Oxygen and trace of nitrogen.
Alder	1·24	87·0	2·97	8·78
Willow	2·02	85·82	2·88	9·28
Dogwood	1·71	83·80	3·28	11·21

Dr. Percy, however, justly observes, I think, with regard to the presence of gaseous matter in charcoal as fuel, that, inasmuch as there is always an excess of hydrogen, over what is required to burn up all the oxygen, the latter must be regarded not only as water, but as water in the solid state or most disadvantageous condition, and its presence is therefore detrimental.

Dogwood being, as I have said, very readily charred, the process of charring is usually conducted at a low temperature; and wood charred at a low temperature always contains more oxygen and hydrogen in its constitution than more highly burnt charcoal. But it by no means follows that the greater violence of explosion of the powder is due to the greater amount of gas in the charcoal. No doubt the gas in the charcoal aids the imflammability; but I think that the main reason is to be found in the fact that charcoal "burnt" at a high temperature is always harder, denser, and a better conductor of heat than when burnt at a low temperature. The conductivity of heat makes it withstand the action of the heated gases, I imagine, just in the same way as the well-known conductivity of heat in copper makes it the best material for resisting the action of fired gunpowder in the bore of a gun; and its hardness prevents it from being reduced to an impalpable dust so readily as slack-burnt or under-burnt charcoal. If the latter be crushed between the fingers it is easily reduced to a fine soft dust, while the former is hard and gritty. It is therefore, I think, because the particles of charcoal are smaller and more readily inflammable that dogwood powders, more especially when the charcoal has been burnt at a low temperature, are quicker than other powders. What appears to be required, therefore, in the manufacture of fine grain powders, is that the particles shall be as fine and as close together as possible, so that the combustion may proceed with sufficient rapidity.

The question, however, may be asked, cannot the slower burning of the alder or willow charcoal be compensated for by making the grains of powder finer? I shall answer this question by a short statement of the experience of Waltham Abbey on the point. I have already referred to the change from F.G. to E.R. powder, in which dogwood was introduced, and to the change from E.R. to J. 2 or R.F.G., in which the size of grain was increased; and I may add that in the most recent manufacture of this powder, the grain is somewhat larger than in the original manufacture, while in addition the density has been increased, a quality which has the same effects to a great extent as size of grain. And now, as far as we know, no powder excels R.F.G. in shooting qualities in the Enfield rifle.

When the Martini-Henry rifle was introduced, it was found that R.F.G. could not be used, because it fouled the rifle. What was the cause of the fouling it is difficult to say, unless it be that the density of the powder was too low and its action too quick, which would also account for the inferior shooting, if we suppose that the great pressure would crush up the bullet and thus interfere with its concentricity of spin and accuracy of flight. It is to be borne in mind that the bore of the M.H. rifle is small and the bullet long, which not only very

much increases its inertia, but also gives less space for the powder to expand. Hardening the bullet has better enabled it to resist the greater strain which is thus produced, but the action I have described is occasionally to be observed in the drop shots which sometimes occur with this rifle, which probably are the result of the bullets being exceptionally soft. The fouling might, therefore, be due to the great length of the cartridge interfering with its thorough ignition with so quick a powder, in the same way as wave action exists in guns, when the powder is not suitable. I can see no reason why this action should not take place with small arms as well as with large guns, and so part of the charge remain unconsumed: and this, I think, is no doubt one cause of fouling, though it is not the only one. The want of proper lubrication by the non-expansion of the beeswax wad, and consequent escape of gas over the base of the bullet is another. Exceeding dryness of the air and want of softening of some of the products of combustion from deficiency of moisture is a third.

In support of the notion that wave action is a cause of fouling, I may mention that a sportsman lately told me, that when he washed out the piece after firing a very fine powder, the water became as black as ink, but that this did not occur when a coarser powder was used.

Shortening the charge by chambering has simplified the problem of finding a suitable powder, but still it has been found that it is only by increasing the charge from 70 to 85 grains, and using a very slow burning powder, that satisfactory results are to be obtained.

The Committee on Breech-loading Small Arms, in their investigations as to the most suitable powder for the M.H. rifle, found that Curtis and Harvey's No. 6 powder gave the best results. They naturally wished to obtain a similar powder from the Royal Gunpowder Factory.

In the opinion of the Superintendent at Waltham Abbey, such a powder could be produced by making the following alterations in the manufacture of R.F.G.:—

1st. Charcoal burnt at a lower temperature;

2nd. The charge taken off the mill bed in a moister condition;

3rd. Pressed to a higher density;

4th. More highly glazed and sifted to a more uniform size of grain.

A sample was sent from Waltham Abbey to the Committee, January 6, 1869, designated W.A. special No. 6, and also another R.F.G. No. 6, to compare with Curtis and Harvey's No. 6. These powders were all of the same size of grain, viz., 14- to 17-mesh. I give the dates as it is important to bear in mind the season of the year.

The Committee reported, February 6, 1869, that on the whole Curtis and Harvey's No. 6 shot best, but suggested improvements might be made in the manufacture of the W.A. powder.

March 20, 1869.—Another sample of W. A. Special No. 6 was sent; and, April 2, 1869, the Committee reported that the results were so satisfactory—15 targets giving a mean figure of merit at 500 yards of 1·08 feet compared with Curtis and Harvey's No. 6, 1·12 feet—as, in

their opinion, to warrant a more extended series of experiments. What the densities and velocities of these powders were I am unable to trace.

Soon afterwards, April 19, 1869, some further specimens were forwarded, with a view to get a higher velocity.

The following table gives a description of these powders, with the results obtained by the Committee :—

No.	Mesh.	Velocity.		Percentage of moisture absorbed.		Density.	Figure of merit, 500 yards, feet.
		Muzzle	Mean diff.	In 24 hours.	In 96 hours.		
		f. s.	f. s.				
3	14 to 17	1,316	10·0	1·6	5·0	1·63	·77
	17 to 20	1,329	6·7				·98
	14 to 20	1,320	8·5				·83
4	14 to 17	1,326	10·3	1·8	5·5	1·60	·78
	17 to 20	1,331	14·1				1·11
	14 to 20	1,335	5·8				·80
5	14 to 17	1,287	7·6	2·0	5·9	1·67	·99
	17 to 20	1,293	8·8				·95
	14 to 20	1,287	9·6				·83
C. & H. No. 6	14 to 17	1,294	10·8	1·8	5·6	1·71	
R.F.G.	12 to 20	..	..	..	..	1·55	

April 30, 1869.—The Committee reported that the three samples of powder, Nos. 3, 4, and 5, gave very good and nearly equal results, superior to those obtained with the Curtis and Harvey's No. 6; that there was no fouling with any of the powders, and that 14- to 20-mesh seemed to give the most uniform results.

The differences in manufacture of each kind were as follows:—

No. 3.—Charcoal not so much burnt as for R.F.G.; worked as R.F.G.; pressed 13½ inches; glazed 12 hours.

No. 4.—Charcoal same as for R.F.G.; worked with rather more moisture than R.F.G.; pressed 11 inches; glazed 5½ hours.

No. 5.—Charcoal same as for R.F.G.; worked with rather more moisture than No. 4; pressed 10¼ inches; glazed 5½ hours.

R.F.G.—Pressed 10½ inches and glazed 5½ hours.

Seeing that No. 4, 14 to 20, gave a good range of grain, and therefore was economical to manufacture, and also gave a high velocity and good shooting, Colonel Younghusband, then Superintendent at Waltham Abbey, gave it the preference.

124 barrels of this powder were made accordingly, and named Rifle Martini-Henry, or R.M.H. powder.

December 7, 1869.—Captain Majendie, Assistant-Superintendent Royal Laboratory, thought this powder fouled the long chamber rifle. Colonel Dixon, January 5, 1870, also was of opinion that this powder was not suitable for either the long or short chambered rifles. And General Lefroy summed up the facts briefly thus: that, at a tem-

perature below or near the freezing point, the small-bore cartridges fouled the rifle, whether made up with Curtis and Harvey's or W.A. powders, and whether fired with long or short chamber rifles; and that, at moderately low temperatures, even up to 50 degrees, they fouled with W.A. powder, but not with Curtis and Harvey's, even in long chambers.

A Sub-Committee, under Lieut.-Colonel Fletcher, was appointed to investigate this matter, and the question of powder was again re-opened.

It will be observed that the density of R.M.H. powder was low, the same as that for R.F.G. as now manufactured. In the next samples forwarded, this defect seems to have been guarded against.

The following powders were sent for trial:—

Date of sending.	Density.	Size of grain.	Distinguishing mark.
January 18, 1870	1·67	14 to 20	A
" "	"	12 to 16	B
" 25, 1870	1·76	14 to 20	C
" "	"	12 to 20	D
" "	1·74	14 to 20	E
" "	"	12 to 20	F
February 3, 1870	1·718	14 to 20	G
" "	"	12 to 20	H

February 14, 1870.—Colonel Fletcher's Committee reported that B and G powders were most suitable, and gave the best results. The velocities of these two powders taken in the Martini-Henry rifle at W. A. were B, 1,296 f.s.; G, 1,301 f.s.

There appears something very definite in these results, the combination of density and size of grain producing almost identical velocities corresponding with that of Curtis and Harvey's No. 6.

Two more powders were forwarded, viz.:—

Date of sending.	Density.	Size of grain.	Distinguishing mark.
February 24, 1870	1·68	20 to 28	K
March 1, 1870	"	14 to 20	$\frac{K}{S}$

The former was intended to obtain a higher velocity in the Martini-Henry rifle, and the latter was for the Snider with an increased charge, and was the large grains obtained in the manufacture of K powder.

March 14, 1870.—The Committee decided to recommend K for the Martini-Henry, and $\frac{K}{S}$ for the Snider.

March 19, 1870.—Specifications were made out, and $\frac{K}{S}$ was called L, for the convenience of Store ledgers.

The specifications were as follows :—

Both powders to be manufactured as R.F.G. Density 1·67 to 1·69; but K to have a size of grain of 20- to 28-mesh, and to give a velocity with 85 grains in the Martini-Henry rifle of 1,330 to 1,370 feet; and L to have a size of grain of 14- to 28-mesh, and with 70 grains to give a velocity of 1,145 to 1,185 feet in the Snider rifle.

April 23, 1870.—K was ordered to be manufactured.

July 4th, 1870.—The Superintendent Royal Laboratory and the Superintendent Royal Small Arms Factory stated, that the shooting in the short action Martini-Henry rifle was indifferent, and they strongly recommended Curtis and Harvey's No. 6 to be used in the Wimbledon competition for that year.

Colonel Fletcher's Committee naturally imagined that this result was due to the manufacture at W. A. not having been kept up to the standard they recommended. But, on comparing a sample with that originally manufactured, the following results were obtained, 12th July :—

	Muzzle velocity.	Mean difference of velocity.	Density.
	f. s.	f. s.	
K	1,374	4·6	1·685
K Supplied to the Committee February 23	1,358	7·9	1·681

which showed no greater difference than might be accounted for by the ages of the powders.

It was also fired against Curtis and Harvey's No. 6 :—

Powder.	Date of firing.	Muzzle velocity.	Mean difference of velocity.
		f. s.	
K	July 21.	1,386	8·3
Curtis and Harvey's	.. .. ..	1,379	10·3
K	July 23.	1,392	5·0
Curtis and Harvey's	.. .. ..	1,389	4·4

which shows a remarkable amount of uniformity in the two powders as regards velocity. The high velocities in both cases were due to the extreme heat of the weather.

Colonel Dixon, the Superintendent Royal Small Arms Factory, still further reported, July 7, 1870, against the shooting of this powder in the Martini-Henry rifle, and suggested that it was due to the powder being too quick, his experience going to prove that a quick powder will not give accurate shooting.

This appears to be the true explanation; and no doubt the inferior shooting was caused by the combined action of small grain and the heat of the weather. What suited the rifle in February was too quick in July.

An attempt was made to remedy this defect by increasing the density; and samples of K_1 and L_1 were made August 8, 1870, of a density 1·718. It was found, however, in the Royal Laboratory, that this diminished the velocity very considerably in the Snider rifle, giving only 1,187 feet, against that of L, 1,232 feet; while R.F.G. gives 1,260 feet. And, though the charge was increased to 75 grains, the shooting was affected by fouling, as follows:—

Rounds.	Figure of merit.	Remarks.
	inches.	
1 to 20	13·15	
21 to 40	19·20	
41 to 61	22·25	
61 to 80	26·8	Fouling.

The Committee also reported, October 17, 1870, to January 26, 1871, on the shooting of K in the Martini-Henry rifle, showing a figure of merit of 14 inches against 10·8 with Curtis and Harvey's No. 6.

It was a favourite idea, with many, that the excellence of Curtis and Harvey's No. 6 depended on the uniformity of the size of its grain, and some L_1 powder was sifted between 14- and 17-mesh, and called L′. The result obtained by the Committee, March 2, 1871, was favourable, the targets being:—

L′.	Curtis and Harvey, No. 6.
Inches.	Inches.
13·1	13·3
11·8	13·8

Fresh samples of this powder were made, March 6, 1871, and April 16, 1871, the former of a density 1·639, and the latter 1,747, which was called M.

The Committee reported, June, 5, 1871, that the results were satisfactory, the targets being:—

Curtis and Harvey, No. 6.	M.
Inches.	Inches.
12·4	12·7

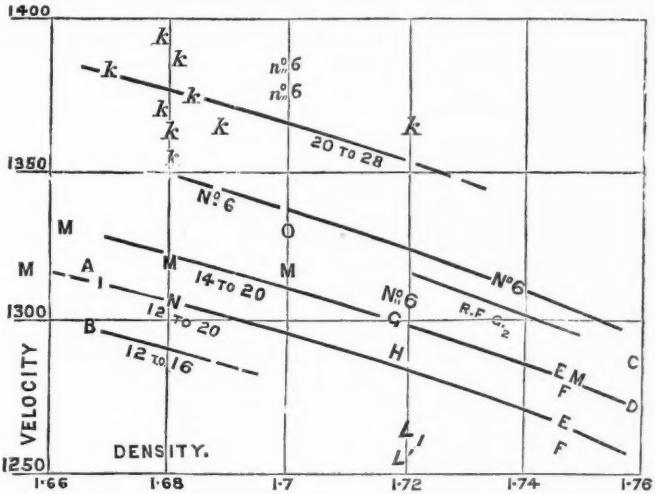
Further trial, however, proved M to be inferior to No. 6.

The following diagram was made out by myself to see whether any general principles could be obtained from previous experience to serve as a guide as to how the best results could be obtained.

I have drawn lines of velocities of the various sizes of grain, and it will be observed that Curtis and Harvey's No. 6 ranks very high in proportion to its size of grain and density, and shows that there must be something in its manufacture which produces this result.

The following particulars will help to explain the natures of the powders which are designated by letters in the diagram. The dates of manufacture and of firing are given, as it is necessary to allow for the age of the powder and the season of the year.

FIG. 1.



Mark.	Date of manufacture.	Density.	Size of grain.	Date of firing.
A	January, 1870	1·667	14 to 20	January, 1870.
B	" "	1·667	12 to 16	" "
C	" "	1·764	14 to 20	" "
D	" "	1·764	12 to 20	" "
E	" "	1·747	14 to 20	" "
F	" "	1·747	12 to 20	" "
G	February, 1870	1·718	14 to 20	February, "
H	" "	1·718	12 to 20	" "
I	" "	1·667	12 to 20	" "
J	" "	1·667	Pass 20	" "
K	" "	1·681	20 to 28	" "
L	" "	1·681	14 to 20	" "
K_1	August, 1870.....	1·718	20 to 28	August, "
L_1	" "	1·718	14 to 20	February, 1871.
L^1	" "	1·718	14 to 17	May, "
M	April 21, 1871	1·747	14 to 17	" "
K	June, July, and August, 1870.	1·67	20 to 28	June, July, and August, 1871.
M	July and August, 1871	1·69	14 to 17	May and August, 1871.
N		1·66	12 to 28	
O		1·7	14 to 28	

What appeared to be required was a velocity of about 1,300 to 1,320 feet. This could not be obtained with the same size of grain and density as Curtis and Harvey's No. 6; but it was anticipated that

by giving a little less density, while maintaining the same size of grain, equally good results would be obtained. Three samples of powder were accordingly made of densities 1·66, 1·68, and 1·7, and they were sifted between 14- and 17-mesh, called M, as before. At the same time two other samples were prepared by sifting some of the powder, 12 to 28, called N, and 14 to 28, called O, so as to get powders a little quicker and a little slower, while giving a greater range of grain.

These samples were forwarded for trial, but the results were not quite so good as Curtis and Harvey's No. 6; and, as the Committee had recommended that no powder which gave results inferior in shooting to Curtis and Harvey's No. 6 should be accepted, the idea of matching Curtis and Harvey's No. 6 by powder made according to W.A. manufacture was abandoned.

I may here notice more particularly the differences between the manufacture of Curtis and Harvey's No. 6, and W.A. R.F.G., to which I have already referred.

(1.) With Curtis and Harvey's No. 6 the charcoal is burned for a much longer time at a lower temperature. This improves the rapidity of burning of the powder, as has already been stated, but at the same time it renders it more hygroscopic, and it is a matter for serious consideration whether a powder, if made on this principle, would retain its keeping qualities if stored for many years. It has always been considered at W.A. a matter of first importance that the charcoal should be thoroughly burned.

(2.) Long milling, in the experience of W.A., had not been found necessary with R.F.G. powder, and much less with R.L.G., and, if carried out at W.A., would seriously diminish the amount of powder that could be turned out.

(3.) Uniform grain would have the same effect in diminishing the out-turn, as the percentage obtained would be only 17 against 40 when the range of grain was greater, as 12 to 20. This does not hurt the private manufacturer, because he has plenty of call for the other sizes, but at a Government factory, where only one sort of powder is required, and nothing is sold, it would be a serious disadvantage.

(4.) Long glazing would also have a similar effect, though in a lesser degree.

A serious attempt, however, was now made to produce a powder which should be in all respects similar to Curtis and Harvey's No. 6, except uniformity of grain. The 12- to 20-mesh was chosen, as it was that of R.F.G., and would give on the average the same size of grain. And, as Curtis and Harvey's No. 6 was now being supplied by contract, the results of the samples sent to the R.L. for target proof were carefully noted. It was observed that within certain limits the higher densities and lower velocities of No. 6 made the best targets.

The first sample was made April 15th, 1872. The density was 1·784, and velocity 1,226 f.s. This was manifestly too slow a powder.

The next sample, April 23rd, 1872, had a density of 1·759, and velocity of 1,300 f.s. The density was still too high, and the shoot-

ing was not good. The mean figure of merit obtained at the Royal Laboratory, compared with Curtis and Harvey's No. 6, was as follows:—

Date of firing.	W.A.	Curtis and Harvey.
	Inches.	Inches.
May 6, 1872.....	12·77	10·57

With 90 grains, however, excellent shooting could be obtained.

The next attempt, May 28th, 1872, was quite successful, the density being 1·745, and velocity 1,328 f.s., and it was found to give results superior to Curtis and Harvey's No. 6. The shooting, compared with Curtis and Harvey's No. 6, was as follows:—

Date of firing.	W.A.	Curtis and Harvey.
	Inches.	Inches.
June 17, 1872.....	9·66	10·16
July 19, 1872.....	9·08	11·11
July 23, 1872.....	9·48	9·96
September 20, 1872.	8·83	9·55
Mean	9·26	10·44

This powder, at first called Q, and afterwards R.F.G.^{2}, has continued to give results superior to Curtis and Harvey's No. 6, the reason being that the average size of the grain is a little larger. Curtis and Harvey's No. 6 is all between a 14- and 17-mesh in size; but, of R.F.G.^{2}, one half is between a 12- and 14-mesh, one quarter between a 14- and 17-mesh, and the remainder between a 17- and 20-mesh. The greater range of grain makes little or no difference.

The charcoal is burned for 8 hours at a low temperature, and the milling is continued for 8 hours. The effects of slack burning the charcoal and long milling I have already explained. The glazing is for 12 hours, and seems to be a refinement by which the density of the exterior of the grain is increased, and thus more time is given for thorough and complete ignition.

Care has been taken to watch the keeping qualities of the powder, lest the effects of the low burning of the charcoal should become apparent, and samples have been preserved and fired from time to time, in some cases as long as three years. There is no doubt that powder made with slack burnt charcoal absorbs more moisture than that with more highly burnt charcoal. The greater density, however, of R.F.G.$_2$ powder helps to mitigate this tendency, and the samples which have been fired show no undue loss of velocity which could be attributed to an extreme absorption of moisture. The moistures, also, have been carefully taken from time to time.

The following are some of the results which have been obtained:—

Date of stoving.	New.		One year old.		Two years old.	
	Moisture	Velocity.	Moisture	Velocity.	Moisture	Velocity.
	per cent.	f. s.	per cent.	f. s.	per cent.	f. s.
September 12, 1872	·44	1,311	1·73	1,279	.. ..	1,298
October 2, „	·49	1,335	1·81	1,294	1·77	1,280
November 2, „	1·1	1,311	1·85	1,284	1·65	1,269
December 3, „	1·12	1,327	1·77	1,284	1·65	1,290
January 2, 1873	·89	1,313	1·77	1,281	1·9	1,273
February 3, „	·60	1,332	1·80	1,274	1·67	1,265
March 3, „	·64	1,308	1·65	1,258	1·72	1,260
April 3, „	·51	1,336	1·37	1,264	1·77	1,275
May 5, „	·9	1,343	1·45	1,266	1·5	1,274
June 2, „	1·1	1,327	1·72	1,274		
July 3, „	·82	1,337	1·3	1,267	1·52	1,269
August 4, „	·96	1,330	1·3	1,279		
October 4, „	1·15	1,314	1·4	1,275	1·7	1,282
Mean	·82	1,325	1·61	1,275	1·68	1,276

The average moisture of the samples when six months old was 1·55, and the average velocity 1,294 f.s., so that we may conclude that it takes one year before the powder attains to its normal condition, after which it remains stable, subject, of course, to the natural fluctuations of the season of the year, and the conditions under which the cartridges are made up and fired. As the samples of powder here under consideration were kept in small open kegs exposed to the air, it is probable that the absorption of moisture and loss of velocity were much greater than will be experienced with powder kept in dry store magazines, or safely sealed up in air-tight cartridges. There appears, therefore, to be no fear of the permanent keeping qualities of R.F.G.$_2$ powder.

The following will give some idea of the relative effects of density in materials, and manufacture. E. means powder the same as R.F.G.$_2$ in every respect except density. A. is the same as R.F.G., excepting density. A.E. is powder having the same materials as R.F.G.^{2}, but manufactured as R.F.G.

In the Martini-Henry rifle the charge is 85 grains, and bullet 480 grains. In the Snider the charge is 70 grains and bullet 480.

Powder.	Density.	Date of firing.	Muzzle velocity.	
			In Martini-Henry rifle.	In Snider rifle.
			f. s.	f. s.
E March 8, 1875	1·654	March 15, 1875	1,370	1,299
A „ „ „	1·653	„	1,338	1,222
A.E. „ 11 „	1·677	„	1,340	1,241
„ „ „ „	1·697	„	1,338	1,230
„ „ „ 22 „	1·650	April 13, 1875	1,340	1,262
R.F.G.$_2$ „ 8 „	1·729	March 15, 1875.....	1,343	
„ „ 22 „	1·726	April 13, 1875	1,321	
R.F.G. April 7, „	1·62	„	.. ..	1,264
„ „ 16, „	1·611	„ 21, „	.. ..	1,281

It will be observed that both the slack burning of the charcoal and the long milling have considerable effect in quickening the powder. Between E. and A. of the same density there is a difference of 32 f.s. in the Martini-Henry, and 77 in the Snider. And, allowing for density and greater age of powder when fired, A.E. excels A. in both rifles. These experimental powders were made when it was contemplated to have one powder for both Martini-Henry and Snider rifles. This could only be done by shortening the Martini-Henry bullet. The powder A. was rejected as unsuitable. The following are the comparative results with the other powders in the Martini-Henry rifle with 80 grains charge and 410 grains bullet.

Powder.	Density.	Date of firing.	Muzzle velocity.
E March 8, 1875	1·654	March 17, 1875.....	1,392
A.E. 11, „	1·677	„	1,362

It was not, however, deemed advisable to lighten the bullet, but the question became, could not E. powder be used with 80 grains with the 480 grains bullet. The velocity obtained, 12th May, 1875, was 1,315 f.s., almost identical with that of R.F.G.$_2$, with 85 grains. It was found, however, to be too violent and split the cartridges.

In order to show how the same question is affected by an increase in the size of grain, with larger charges, I may give the firing of the following samples of field gun powders in the 9-pounder and 16-pounder guns.

Powder.	Size of grain.	Density.	9-pounder gun.		16-pounder gun.	
			Muzzle velocity.	Pressure.	Muzzle velocity.	Pressure.
			f. s.	Tons.	f. s.	Tons.
P. and W.R.L.G. Lot 747	4 to 8 mesh.	1·672	1,395	10·7	1,369	13·8
W. A. Experimental, R.F.G. dust. October 3, 1873....	⅜″ cube	1·674	1,440	11·2	1,436	15·8
W.A. Experimental, common charcoal, Jan. 10, 1874....	„	1.679	1,228	5·2	1,283	8·0

The densities being nearly alike show that the dogwood powder, though its grain is very much larger than the service R.L.G., Pigou and Wilks, lot 747, is a quicker powder; and this fact becomes still more apparent when contrasted with the January 10, 1874 powder of the same size of grain, and nearly same density, but made with alder and willow charcoal. The dogwood powder has been fired in a chambered 9-pounder gun with 3 lbs. of powder and 12¾ lb. shot, giving a velocity of 1,700 f.s., with a very high recorded pressure of nearly 40 tons, showing that it is a violent powder.

I am able to pursue this investigation still further by contrasting the effects of dogwood and common powders in the 8-inch grain.

Powder.	Density.	Size of grain.	Muzzle velocity.	Pressure.		
				A.	B.	C.
			f. s.	Tons.	Tons.	Tons.
Hall and Sons .. Dogwood powder Milled two hours	1·82	1″ cube	1,476	12·5	13·6	14·0
,, ,,	,,	⅝″ ,,	1,447	20·6	20·4	19·4
Hall and Sons.... Dogwood powder Milled eight hours	,,	1″ ,,	1,516	12·0	12·4	12·2
,, ,,	,,	⅝″ ,,	1,508	20·2	20·3	18·7
W.A. December, 1873, common powder	,,	1″ ,,	750	0·0	0·0	0·0
,, ,,	,,	,, ,,	730	0·0	0·0	0·0

These powders were almost identical as regards density, having been subjected to an extreme pressure of nearly 30 cwts. to the square inch. We have, therefore, a strong contrast of the differences caused by the nature of the charcoal, and also by the milling and size of grain.

Comparing Hall's dogwood inch cubes with the Waltham Abbey cubes made with common charcoal, we observe that the velocity with the latter is only about one-half of that with the former, and the pressure was not sufficient to crush the copper crusher gauges. In both cases, also, with the dogwood powders, the inch cubes give higher velocity than the five-eighths cubes, while the pressure is not much more than one-half.

With both sizes of grain in the dogwood powders the longer milling has proved beneficial in increasing the velocity and reducing the pressure. The date of firing of Hall's samples was September 19th, 1873.

They were fired again, November 14th, 1873, after being exposed night and day in open barrels to the weather since the first proof, with the following results:—

	Muzzle velocity.	Pressure.		
		A.	B.	C.
	f. s.	Tons.	Tons.	Tons.
Milled 2 hours { 1″ cube	1,306	7·3	6·9	6·9
Milled 2 hours { ⅝″ cube	1,233	6·0	5·9	5·8
Milled 8 hours { 1″ cube	1,401	10·5	10·8	10·6
Milled 8 hours { ⅝″ cube	1,399	11·0	10·6	10·8

This shows that the longer milled powder is very much the best able to resist the action of the weather. Of course no powder will ever be called upon to stand so severe a test of its keeping qualities as this powder was subjected to. My object, however, is to bring out the special features of the various powders.

I am able to go another step in the same direction. In making experimental powders for the 80-ton gun, powder from new materials and reworked from Merchant's L.G. have been used. It so happens that the L.G. powder used showed evident signs of the charcoal being slack burned, probably with the view of passing the old mortar proof successfully by giving a good range. It also, of course, received the extra milling necessary to convert it into the new powder. The contrast, however, is not nearly so strong as between dogwood and common charcoal, and the difference in milling is not great. The following are the results of two sets of samples fired preliminarily in the 38-ton gun.

Powder.	Density.	Size of grains.	Date of firing.	Muzzle velocity.	Pressure.		
					A.	1	2
				f. s.	Tons.	Tons.	Tons.
W.A. rework	1·82	2″ cubes	4/12/75	1,350	15·0	13·7	15·2
Dec. 2, 1875	1·81	1·7″ cubes	„	1,380	17·6	17·0	17·2
W.A. new powder	1·74	2″ cubes	16/2/76	1,375	25·0	25·5	22·9
Feb. 5, 1876.....	1·76	1·7″ cubes	„	1,387	22·3	22·2	22·5

Now what conclusion are we to draw from these apparently steadily consistent results. It would appear that the way to make the best powder is to prepare the materials with a view to make the powder as rapidly burning as possible, and then to moderate the combustion by density and size of grain. If the powder be not quick burning the density very much affects its rate of burning, and, as was seen with W.A. inch cubes of high density, the powder becomes much too slow for any gun. Now it will occur to most that, as soon as the pressure rises in the bore of the gun, the density of powder remaining to be burnt becomes very much increased; and, though the powder used be of low density and consequently quick burning on that account, it will soon become a slow-burning powder. This is the condition we most wish to avoid; and, therefore, it is better to start with as high a density as possible and have it naturally-quick burning, and thus the rate of combustion will be less affected when the pressure rises in the bore of the gun.

These conditions would, I believe, hold absolutely true were it not for another feature in the burning of grains of powder which accelerates the combustion of powders of lower density, though otherwise slower burning. I refer to the porosity of the grains, on which I more particularly dwelt in a previous paper read here. With the same density of grain, powders made with hard burnt charcoal are more porous than those made with slack burnt charcoal, because, the particles of charcoal being coarser, the spaces between will be proportionately larger; and also the particles of charcoal, being denser, will occupy less space, and so leave more room for interstices. The crushing pressure of these particles also we may suppose to be higher than with soft charcoal, which will enable them to build themselves up in accidental positions,

and thus give rise to uneven densities in different portions of the grain itself. Under the intense pressure in the bore of the gun the flame becomes forced into these spaces, and the less dense portions of the grain burn more rapidly than the harder portions, and thus give rise to that particular pitted and burrowed appearance of unconsumed grains of powder which are picked up after the discharge of the gun, with which we are all familiar. It is difficult to say how far the flame becomes forced into these channels, but the effect must be that from each small centre of penetration the combustion proceeds more rapidly as larger and larger surfaces come under ignition, and so an increased amount of gas is generated. It is a great mistake to assume that under all circumstances the combustion proceeds in regular successive laminæ from the surface to the centre of a grain of powder. With very high densities 1·82 to 1·84, when the powder probably has been subjected to a pressure equal to the crushing strain of the particles, I believe no appreciable interstices exist, and then the grain does burn regularly from surface to centre. The rate of burning then depends on the fineness of the particles of charcoal, each particle requiring to be consumed before the flame can reach the next to ignite it; and this no doubt accounts for the very marked difference in burning of W.A. 1″ cubes of ordinary charcoal, and Hall and Sons 1″ cubes of dogwood charcoal. With lower densities, however, the conditions are different, and, though the slack burnt charcoal still retains its greater rate of combustion, yet the greater certainty of porous channels, or unequal densities in the grains with harder charcoal enable it with more certainty to take advantage of the accelerated rate of combustion I have noted, and so tend to a great extent to reduce the difference in ultimate effect. It is mainly, in my opinion, due to this fact, that our cubical powder is able to match to so great an extent the prismatic powder used by some foreign governments. In the prismatic powders the channels are introduced into the grains of powder intentionally, so that there may be an accelerated rate of burning from them as centres as the combustion proceeds. The manner in which these holes are made, however, renders it uncertain whether their whole surfaces are ignited, as we find with pressed surfaces that they are generally only ignited from points; and, in fact, portions of grains of powder are often picked up of which the surface never appears to have been ignited. If the holes could be bored so as to give more readily ignitable surfaces, it is probable that the combustion would be much improved. Prismatic powder has to be made of much lower density than granulated or broken powder, in order to compensate for the greater difficulty of ignition.

It will be observed with prismatic powder that the sizes of the prisms are of no consequence provided that the channels are proportionately numerous and suitably placed. And in support of this notion I have advanced that our powders are porous, I will give the following results obtained by experiment with powders of different sizes of grain with the same density. The powders were pressed in the same press-box at the same time, so it is tolerably certain that their densities were identical.

Powder.	Density.	In 8-in. gun, 35 lbs. charge, 180 lbs. projectile.				
		Muzzle velocity.	Pressure.			Length of cartridges.
			A	B	C	
		f. s.	Tons.	Tons.	Tons.	
W.A., Sept. 30, 1875. Rework						
1·5 inch cubes	1·76	1,471	16·2	15·5	15·1	20¼″
1·7 „ „	„	1,471	16·8	16·1	14·1	20¼″
2·0 „ „	„	1,452	15·7	15·2	15·2	21″

If we make allowance for difference in lengths of cartridge, these three samples give almost identical results in the 8-inch gun; and when we come to the 38-ton gun the larger cubes by no means show to advantage:—

Powder.	Density.	In 38-ton gun, charge 130 lbs., projectile 800 lbs.			
		Muzzle velocity.	Pressure.		
			A	1	2
		f. s.	Tons.	Tons.	Tons.
W.A. Sept. 30, 1875. Rework					
1·5 inch cubes	1·76	1,460	26·1	27·7	19·7
1·7 „ „	„	1,440	27·3	26·5	24·5
2·0 „ „	„	1,409	28·7	24·5	22·5

Take, however, the following samples of powders of equal but higher densities, and the effect of size of grain is very marked.

Description.	Density.	38-Ton gun.			
		Muzzle velocity.	Pressure.		
			A.	1	2
		f. s.	Tons.	Tons.	Tons.
W.A. December 2, 1875. Rework					
1·5 inch cubes	1·81	1,396	22·2	22·2	21·2
1·7 „ „	„	1,380	17·6	17·0	17·2
2·0 „ „	„	1,350	15·0	13·7	15·2

Both of these sets of samples were made from rework L.G., with the same description of slack burnt charcoal. I have already compared the latter 1·7 and 2-inch specimens with those of W.A., February 5th, 1876, of lower density made from new materials where the charcoal is more burnt. It will be observed that, with the February 5th, 1876, specimens, the pressures do not go by size of grain, showing that

the powder is porous owing to the low density; and, as already stated, though the velocities are about the same as in the last samples given, the pressures are higher, which bears out my theory about the higher densities and quicker burning materials giving the best results.

Of course I do not give these samples as *proving* the question, but merely as illustrations of the features I wish to bring before you. We have had samples, especially those made by Messrs. Hall and Sons, of Faversham, of powders of low densities and hard burnt charcoal which have given the very best results. They have been tried, however, with powders only 1″ cubes, and density 1·75, giving results too quick for the 38-ton gun with large charges.

This leads me to the consideration of the third and last feature I wish to lay before you. I believe the action in that case to be modified by the slow burning of the particles of charcoal themselves, these particles being so large and dense that, if we suppose an extreme case, all the particles may be ignited very rapidly, but the mean time of burning of the charge depends on the burning of a single particle. Charcoal has never been burnt at Waltham Abbey to an extent so as to produce this result, so that I am unable to give any accurate data as to how far this method may be carried out on a large scale. But I think it is worth investigation.

I may now sum the different features in powders for large guns, by which the rate of burning may be modified.

1. A quick burning powder, with a high density, and no appreciable porosity.

2. A moderate burning powder, with a moderate density, leaving moderate porosity.

3. A very slow burning powder, with very large porosity.

Powder may be produced to give very good, and possibly equally good, results, by any of these methods, but, I think, probably it can be produced best and with greatest certainty by the first method. It is, however, by far the most expensive, owing to the greater time required to manufacture.

The second method, with a slight tendency towards the first, is that by which powders have hitherto been made at Waltham Abbey. It is the cheapest, but it depends to a great extent on the most uncertain of all the qualities, viz., porosity. The only means by which this uncertainty can be neutralised is by systematic proof and careful mixing. When this is properly carried out, the results can be relied on with perfect certainty.

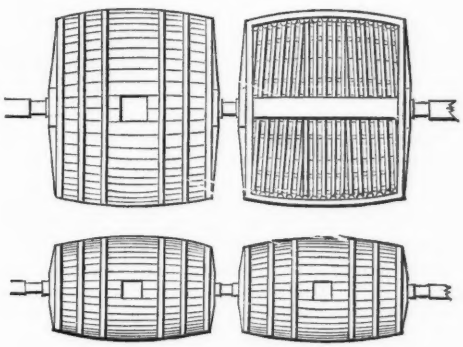
In all cases size of grain is a most important element which can never be dispensed with, owing to the facility which it gives for the complete ignition of the charge, and the total elimination of wave action, which is so very destructive to the bore of the gun. From observation of the good results which were obtained by Hall's inch cubes in the 8-inch gun, I was led to suggest the trial of 2-inch cubes for the biggest guns, for, if we double the diameter of the bore of the gun, we ought also to double the length of the side of the cube of powder required for it. With such large grains no wave action is now to be observed even if the charge be ignited in rear. It

is, therefore, a safe and sound principle to keep the grains as large as possible, provided other qualifications are not unnecessarily sacrificed. Were, however, our heavy guns breech-loading, the result of my observations lead me to believe that, if the cartridge were ignited along the whole centre from the rear, smaller grain and denser powder could be safely used, and greater efficiency thus obtained.

I may mention a difficulty which has been encountered in the manufacture of these large cubes. In glazing in the ordinary manner, it has been found that the amount of heat generated is not sufficient to make the powder sweat in the glazing barrels. The portions thus rubbed off are not pasty enough to adhere to the sides of the barrel, but remain in a state of dust, which adheres to the cubes, and requires to be removed before the powder is finished and black-leaded. It is anticipated that, by using one large instead of four small glazing barrels, not only will this objection be removed, but larger units will be obtained for the after process of mixing. The system of mixing, and proof of pebble-powder, I have explained in a previous paper. It is obvious that if a sample of 130 lbs. of cubical powder be fired from each batch, the batches must be large to prevent an unnecessary expenditure of powder. By adopting a unit of 1,600 lbs. instead of 400, as in the case of pebble-powder, a batch of 16 times 1,600 lbs. can be obtained if four ordinary stovings be reserved before the powder is finished. For this purpose a finishing reel, to contain 1,600 lbs., has also been made. Cubical powder will not pass through a hopper in the same way as pebble-powder, because the grains are so large, but, by means of this mixer, it is anticipated that, if required, as many as 16 different batches can be made uniform, by taking a barrel from each for a run. The following diagrams will give an idea of the sizes of the glazing barrel and mixer as compared with an ordinary glazing barrel.

FIG. 2.

Large glazing barrel. Mixer.



Ordinary glazing barrels.

These large cubes afford special facilities for taking densities, and an instrument was designed by me for this purpose. Where the grain of the powder is small, and the surfaces touch each other, the air has to be exhausted before the mercury is allowed to enter the globe in the ordinary densimeter; but in this new design, the cube is simply immersed, and it is found the air does not adhere to the surface when it is held by three small sharp points. Fig. 3 shows the design of the instrument. Fig. 4, the method by which the cube is held in its place, only one point being shown. The bulbs B give buoyancy when no powder is immersed, so that the point E just touches the surface of the mercury. When the powder is immersed, weights are added till the point E again touches the surface, and thus the density can be calculated. It has been found in taking the density in this manner that the cubes vary very considerably, and a large number have to be tried before an average result can be obtained. The cubes, however, after being operated on, can be returned again whole by simply brushing off any mercury which adheres to them.

FIG. 3.

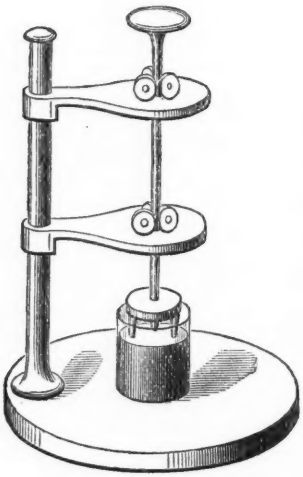
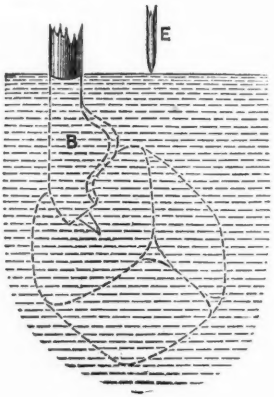


FIG. 4.



I trust that the remarks I have made will show how deeply interesting and important this subject is, and how steadily and surely light has dawned on us, with the aid of the proof tests, which were inaugurated and carried out by the Committee on Explosives. I have had the opportunity of studying the matter for now nearly five years, during perhaps the most interesting period; and I hope it may not be considered inappropriate to have laid the results of my observations before you. Though many of the deductions I have drawn are merely my own theories, they are the fruit of long and careful study, and they

will not, I feel confident, be lost sight of by those who have to do with powder at Waltham Abbey, or elsewhere.

The CHAIRMAN: I think it only remains for me to express what I am sure is the feeling of the meeting generally, the very great interest with which they have listened to the lecture, showing, as it does, an immense deal of research upon a very difficult, and if I may add, a somewhat dry subject. That dry subject has certainly been given to us mixed up with a great deal of interesting matter. In saying so, I should not lose sight of its great importance. For years past the whole of the military institutions of our country have been more or less under review, and we may add to that, that our ordnance, our rifles, and our powder have also been under review; and next to keeping our powder dry, which I look upon as most essential under the present circumstances of the world, the most important thing connected with this subject is, that we should have the best possible powder that we can possess. I believe Major Morgan has, I won't say actually solved the question, because I do not believe in finality in anything, and I think that it is quite possible, considering the great march we have made in the science of explosives as well as in the science of big guns and rifles, that some day or other an explosive superior to gunpowder may be discovered, but pending that time, I may say I believe we have arrived at almost as perfect a solution of the powder-question as can be attained under the present circumstances and with our present lights. I was pleased to observe that the lecturer divided his subject into two parts. He took first of all the small arms powder, and he brought us by gradual stages up to the latter, which he showed us was the best possible powder that could be produced under the circumstances, showing us that this was only done by long and patient perseverance, because as I understood, from 1869 to 1872, various experiments were made, and it was eventually proved that the best powder could only be produced by long milling and by slack burning of the charcoal. I observe our lecturer is in favour of breech-loading guns. He says, "I should prefer, however, to see our heavy guns breech-"loading, and the cartridge ignited along the whole centre from the rear, when "smaller grain powder could be safely used and greater efficiency thus obtained." I have always supposed that in any breech-loading guns of heavy calibre, the explosion of a great mass of powder is an operation that would require a great deal of forethought to be carried out with safety. Certainly I do not suppose for a moment that which was called the *poudre brutale* could be used with any great safety. It may be quite possible, as our lecturer observes, that the small grain powder might be rightly or safely used, but there may be other reasons which I think I am hardly competent to go into, as to the gradual ignition of the powder, which I believe is an essential of the large grain powder in the guns, which might not make a small grain powder so useful for the purpose. On all these matters I speak with a great deal of humility. Though I am here in a particular position, presiding over a meeting which has listened with a great deal of attention to all that has fallen from our lecturer this evening, I do not think it is necessary and I certainly should be the last, to wish to go into a controversy on these matters. I had rather hoped that some gentleman in the meeting would have given us a few observations upon this most interesting lecture, and that the meeting generally should have been able to come to some conclusion after a discussion which would have been more or less favourable. It now, I think, only remains for me to express again the very great pleasure with which I have listened to a lecture most interesting as I have said, and most important; and I think there is an additional matter of interest pertaining to it, that it comes from a gentleman who has served at Waltham for the last five years with very great credit to himself and with very great advantage to the public; and when a gentleman like Major Morgan comes to an Institution like this, and is good enough to give us a highly scientific lecture, from which all of us can draw more or less profit, I am sure he is entitled to our very best thanks.

Rear-Admiral SELWYN: I should like, my Lord, with your permission, to ask the lecturer one or two questions. Perhaps Major Morgan would inform us first what the cost of dogwood is compared with the other charcoal, and also the increased cost due to the longer time required in working. Also what is the size of the cartridge made with a prismatic powder as compared with the cubic. I am asking,

in fact, very nearly, what is the specific gravity, but "size of cartridge," would convey a better idea to most of my brother Officers; if he would give us any idea of how much additional space is required by reason of the prismatic powder being (I suppose I must not call it less dense) but more porous, and the difference also between those two and the R.L.G. There is another question as to the wave-action of which Major Morgan spoke. Whether that wave-action is not more probably due to the slow starting and the continued push, as compared with the sudden action of the quicker powder than to any other peculiarity of the powder. And I should like also to observe on the question of hydrogen and oxygen contained in these powders Professor Macquorne Rankin's statement in this theatre some years ago (which is a perfectly sound authority upon the subject) was, that for every unit of oxygen present, eight units of hydrogen will be rendered nugatory, and as the total heat of combustion represented by the burning powder must also be the total effect of gaseous pressure, it is clear that not only is the whole of the hydrogen absorbed, but there is an excess of oxygen in a peculiar state which may possibly combine with the carbon, as I have had reason to see in other experiments connected with fuel, and produce a more vivid and intense combustion. It is under pressure and it combines with the carbon. One would say at first sight that the lower quantities of oxygen and nitrogen ought to give the better effect because less hydrogen would be rendered nugatory. As to the presence of gaseous matter, we must consider that powder, if it be properly burnt, all becomes gaseous, but the quantities of oxygen, hydrogen and nitrogen contained, besides the carbon, do affect the total heat of combustion in every case were combustion takes place, and very notably so. I think I might ask also whether there has been any change for the better in the velocities obtained over those obtained by the old powder. It was called *poudre brutale*. It was *poudre brutale* if fired under certain conditions and in certain guns, but the question will arise necessarily whether in seeking after a good gun, first we did not make a weak gun; secondly, whether in seeking after a powder to fit that gun, we have not made weak powder; and thirdly, whether in making that weak powder slow-burning powder, we have not necessitated much longer guns, which guns, I am sorry to say, seem likely to surpass very much the limits that can be afforded to them of space in casemates. I ask these question simply to recall attention to the fact that we do not do wisely to overlay differences or conceal difficulties as they arise, instead of candidly and openly acknowledging them. The probability is that as soon as we have a powder to suit the Martini-Henry, we shall have to get some other form of rifle to suit the powder. It seems very doubtful whether this question ought not to have been gone into as the very first consideration in making artillery of whatever size—the powder first, the projectile second; the cartridge, if there be a cartridge, third, and last of all the arm.

Captain BURGESS: I should like to ask Major Morgan whether his attention has been drawn to a cartridge for heavy ordnance proposed by Mr. Scott Russell last year, in which he intended that the powder should be built up in the cartridge in hollow cylinders of powder, the centre being filled with condensed powder, so that combustion should take place from the centre, and that the cartridge case should be made of metal?

Major MORGAN: In the first place I am very much indebted to your Lordship for the kind way in which you have spoken of the paper I have read, and for the interest which you have shown on the subject. And, indeed, I may say I am most indebted for the accuracy with which your Lordship found out a flaw in this paper. I am aware I had no right to go into the subject of guns at all in reference to the matter in hand, and it was merely incidentally that I did so. I have a specimen of powder here, made by the Italian Government, three-eighths of an inch cubes, and it is a slower burning powder than the Waltham Abbey two-inch cubes. It can never be used, however, in large charges, because you could not get the whole charge ignited; and the difficulty is the wave-action. The ignition takes place in one part of the cartridge, and unless it can be distributed through the whole charge, you get wave-action, which spoils the efficiency of the charge. The only way out of that difficulty with such a powder would be to ignite the cartridge up the middle and make radial channels, so as to communicate the flame to the whole cartridge as quickly as possible. I may say I am not in favour of breech-loaders to the extent

which has been supposed; and in the last paper that I read before this Institution I showed as far as I could, that our Woolwich guns are better than any continental guns. However, I have had the honour to propose a breech-loader, which I think is better even than them, and it is only with reference to that gun that I mention the subject. With regard to the cost of powder, I should think if you accept the saltpetre and sulphur, the cost of powder made as R.L.G. 2 powder would be about double that of ordinary powder, the cost of every operation in working with the dogwood powder being about doubled. If we can obtain the same results, as I believe we can, with careful mixing and careful proof, I think we shall have no cause to change our present manufacture. But I am not here simply to advocate or praise up any one system; I am here to bring forward, after the experience I have had, the special features of the manufacture, not with a view to the solution of the question, but simply to lay all the features before those who may have to do with powder at this or some future day. There are a great many questions that I do not feel justified in going into, and do not come to meddle with on the present occasion. It is quite sufficient to have brought the special features of the powder made, before this meeting without ranging to other subjects which, to a great extent lie beyond my province. The size of the cartridge for prismatic powder I should think would be less than that for pebble or R.L.G. It would be packed closer together, and would go in a smaller space. I agree with Admiral Selwyn that there is always a little excess of hydrogen to oxygen, but according to Dr. Percy, one of the best authorities we have on the subject, all the oxygen is positively detrimental and might as well be water in the shape of ice, so that it is not the quantity of gas that makes the rapidity of burning of the powder, but, as I have said, it is the fineness of the particles of the charcoal. With regard to what Captain Burgess said as to Mr. Scott Russell's cartridge, I was here and heard that lecture, which was most interesting in theory. His suggestion was similar to one that I entertained twelve years ago for my own gun, but whether it would succeed or not I could not venture to say until I had seen it tried. I do not believe in any theory that is not founded upon facts, for I have found in gunpowder-making that practice has led to entirely different results to those which were supposed would have followed on theoretical grounds. With regard to differences in powder, you can account for them all in this way—that we are all learning, and what we knew last year, we must alter our opinion about this year. At this time last year I could not have drawn the conclusions I draw now, and of course next year I may have to change my mind again. At the same time there is no reason why I should not lay the grounds of my present conclusions before those who are able perhaps to improve upon them, and to form an opinion and estimate at their value.

Colonel Lord WAVENEY: I may notice a remarkable confirmation of what has been stated in reference to the powder adopted by the Italian Government. The only Italian gun which I have seen was rather less than the equivalent of our six-pounder, the calibre being 2·950, against 3·668 (six-pounder). It was a much longer gun than ours, which, as has been said, gives more complete combustion, and that is what we desire in this particular description of powder. I saw this gun fired with blank. It is a gun which may be very effectively used for the purposes of auxiliary forces. They have also guns equivalent to our sixteen-pounders, used for breaching service in the field. I did not see them employed. It is clear that an additional length would help the combustion of this more perfectly polished powder. I am glad to be able to give this confirmation of the theory laid down with regard to the additional length of guns requisite for the development of a thorough combustion.

LECTURE.

Friday, March 31st, 1876.

LIEUT-GENERAL SIR LINTORN SIMMONS, K.C.B., R.E., &c., &c., in the Chair.

THE COMPARATIVE COST OF THE ARMIES OF DIFFERENT NATIONS, AND THE LOSS TO A COUNTRY BY CONSCRIPTION.

By Captain J. C. ARDAGH, R.E., F.R.G.S., &c.

PART I.

THE subject which I have been asked to investigate depends mainly upon financial statistics, and is consequently dry, but in laying the results before you I shall endeavour, as far as possible, to dispense with superfluous figures, and to confine the numerical statements within narrow limits. Yet, as money questions are inseparable from figures, I must ask you to tolerate the inevitable.

In considering the comparative cost of different armies, the first question to decide, as a preliminary step to the investigation, is—the standard of comparison; and here, at the very outset, there is an extensive field for difference of opinion, apart altogether from the difficulties to be subsequently encountered in obtaining statistics and manipulating them.

A description of some of the more rough methods occasionally employed will somewhat clear the ground.

A favourite plan in England is to divide the amount of the Army Estimates by the number of soldiers on the establishment. It used to be said that our Army cost £100 per head per annum. The home and colonial establishment for this year numbers 127,562, and the Estimates amount to 14 millions. Dividing one by the other will give about £110 per head. From this it would appear that we do not now get as good value for our money as we formerly did; but, notwithstanding the increased cost of articles of consumption, or, what is the same thing, the diminished value of money, this is a transparent fallacy, for we really get so much more for our £110 now, than we did for our £100 fifteen or twenty years ago, when the Militia and Volunteers had not reached their present efficient state, that we have every reason to be gratified. The fallacy lies in this—that the peace establishment of the regular forces is a most inaccurate standard whereby to measure the military strength of the country. The Reserves, the Militia, and

the Volunteers are altogether omitted, and yet they constitute numerically far the more considerable portion of our forces. If we deal with Army Estimates "en gros," there seem to be only two modes which can give reliable results, each in its particular way.

The first is to take the average number of men kept continually under arms as a divisor; this will give a tolerably fair financial result. The second is to take the number of efficiently trained soldiers who could be produced on a sudden mobilisation—the ultimate war strength, in fact; which is the aim and end of our expenditure.

By the average number of men continually under arms is to be understood—

a. All the Regular forces.

b. A fraction of the Reserves, dependent on the number of days' training which they are to receive, which is at present somewhat uncertain. Twelve days was spoken of, and on that assumption one-thirtieth of the number may be included.

c. Under heading *c* come a fraction of the Militia, who are under arms for a month in the year, and their recruits, something over one-fourth of the total number, for two months. One-eighth of the number attending training may be taken as an average constantly under arms.

d. A fraction of the Yeomanry and Volunteers, more difficult to estimate from the peculiarity of their training, but one-thirtieth of the efficients may be assumed as a liberal average.

The numbers will then stand as follows—

a. All the Regular forces	127,562
b. Reserves, $\frac{1}{30}$th of 31,000	1,033
c. Militia, $\frac{1}{8}$th of 118,000..	14,750
d. Volunteers, $\frac{1}{30}$th of 180,750	6,025
Total average under arms	149,370

Dividing the 14 millions of the Estimates by this number, we arrive at the cost per man under arms as £93. It is hardly necessary to remind you that this includes great guns, small arms, military stores, fortifications, barracks, pensions, and everything else appertaining to the maintenance of the Army.

The other basis of calculation suggested, was the war strength of the Army—the number of efficiently trained soldiers who could be produced on sudden mobilisation.

This may be said to comprise, nominally—

a. The Regular Army	127,562
b. The Reserves	31,000
c. The Militia	118,000
d. The Yeomanry	12,000
e. The Volunteers, 168,750 (one-fourth)	42,188
Total war strength	330,750

LECTURE.

Friday, March 31st, 1876.

LIEUT-GENERAL SIR LINTORN SIMMONS, K.C.B., R.E., &c., &c., in the Chair.

THE COMPARATIVE COST OF THE ARMIES OF DIFFERENT NATIONS, AND THE LOSS TO A COUNTRY BY CONSCRIPTION.

By Captain J. C. ARDAGH, R.E., F.R.G.S., &c.

PART I.

THE subject which I have been asked to investigate depends mainly upon financial statistics, and is consequently dry, but in laying the results before you I shall endeavour, as far as possible, to dispense with superfluous figures, and to confine the numerical statements within narrow limits. Yet, as money questions are inseparable from figures, I must ask you to tolerate the inevitable.

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c. The Militia	118,000
d. The Yeomanry	12,000
e. The Volunteers, 168,750 (one-fourth)	42,188
Total war strength	330,750

It is scarcely necessary to point out that this is a maximum limit, and that the numbers actually forthcoming, would be below it. The same is true, but in a less degree, for other countries than England.

Dividing our fourteen millions by three hundred and thirty thousand, we have the cost per head of war strength £42 per annum.

If the Imperial troops on the Indian establishment and their cost, together with the whole of the Volunteers be added, the war strength would be raised to 520,000, and the cost per head diminished to about £36 per annum; but this is mentioned merely incidentally, and is not intended as a comparative statement. The introduction of the native forces in India, numbering 440,000 men, or of the Canadian Militia, whose active strength is 30,000, would only confuse matters still further.

In going so far, the military establishments of this country only have been dealt with, and purposely so, for a single example indicates the process followed in other cases.

The mode in which these figures have been arrived at is altogether empirical, and most of the details involved are matters of opinion. In the case of England, for instance, one critic may consider that the militia should be excluded from our war strength, while another may ask why only one-fourth of the Volunteers have been included, or why the Irish Constabulary are left out, and so forth.

In dealing with the statistics of foreign armies, the same class of difficulties arises. It is true that we possess the most complicated military system in the world:—we have a Home Army, a Colonial Army, and an Indian Army, all more or less interwoven; and we have Regulars, Militia, Volunteers, and native troops, with various terms and systems of enlistment. In other countries there is, in those respects, far more simplicity; but great latitude exists for difference of opinion. Is the French *réserviste*, who has only served six months in the ranks, to be reckoned as a trained soldier? Are the hundred and forty thousand Cossacks of Russia to be counted as cavalry? No rigid rule can be laid down; the decision must be left to the discretion of the computer in each case; and it may be broadly assumed that, where the calculations have all been made by the same hand, the results are capable of comparison, which is the ultimate aim of the investigation.

What has been said regarding numbers, applies with still more force to money.

No two countries keep their budget accounts on the same system, and none give *complete* information regarding the cost of their troops in an accessible form. In the French budget, military pensions are borne on the Finance Estimates; while, in America, a very large Survey and Meteorological Department is charged in the Army Estimates. Russia maintains, perhaps, a judicious reticence. Austria gives most detail. France nearly as much. Germany less. England, America, and Italy, supply a very great number of figures, and a very small amount of information.

I have gone into them all except Russia, and I may say that

America gives no information at all, and in the very wide gap between America and the great Continental Powers, our budget comes in as a link—containing very much more than the one, and very much less than the others.

Before going further into details, it will be interesting to consider some other general relations between military expenditure in various countries. Table I has been prepared with a view of illustrating the incidence of the military burden on the purse and person of the inhabitants; and here it must be pointed out that, in different countries, the extent to which expenditure from general revenue reaches in local, county, or provincial matters, varies very widely. The county police in England, for instance, are paid from local rates; while the Italian carabineers, who are, in fact, a gendarmerie, are really the *élite* of the regular army, and are of course paid by the State. The railways are, in some cases, in the hands of the state, and, in others, of private companies.

A great number of the roads and canals, and public works, in France, involving an annual expenditure of above six millions of pounds sterling, are administered by the State; while, with us, these are all matters of private enterprise. And to complicate affairs still further, the amount or proportion of the National Debt, and its charge on revenue, in various States, differs very widely.

The result is that the annual budget is not a very good comparative standard of the cost of government and administration. This, however, is not the place to remodel the financial systems of the world; and the discrepancies are only alluded to in order to avoid misconception.

Turning to the tabular statement of statistics, on line 3 will be found the amount of annual taxation per head of population obtained by dividing the budget by the population. The figures are tolerably uniform, with the exception of Russia and America. The proportionately small amount of taxation in Russia, 18*s*. per head, is accounted for by the fact, that there are several local governments within the Empire, which administer their own finances. The Grand-Duchy of Finland, the Kingdom of Poland, the Province of Courland, and others, have special local administrations and taxation apart from that of the Empire.

In America, as is well known, each State of the Union provides for its own internal administration, and the amounts voted by Congress are therefore correspondingly diminished.

France also labours at the present moment under the pressure of her new and enormous debt and the re-organisation of her Army; while, as already mentioned, the ordinary budget is swelled by Algeria and the Public Works sections.

The average taxation per head in the principal European States is about forty-five shillings per annum. England and France are above. Germany, Austria, and Russia, are below this average.

Passing to the amounts in line 5, obtained by dividing the Army Estimates by the population, the cost of the Army per head of population is arrived at.

The small sum of four shillings per head in America is very simply accounted for by the very insignificant force maintained. Russia, Austria, and Italy, stand at six shillings per head; England and Germany at nine shillings per head; and France at the top of the list with eleven shillings, mainly due to re-organisation.

The proportion of revenue spent on the Army varies from 13 per cent. in Italy, to 21 per cent. in Germany.

The next group of figures relates to the peace strength of the Armies. The average number under arms, computed in the manner already mentioned, varies between exceedingly wide limits. America has only 28,000, while Russia has 675,000.

The incidence of personal military service on the population in time of peace is illustrated by the next line of figures:—

In France, there is one man under arms for every 82 persons of the population. In Germany, 1 in 98. Then follow Italy, 1 in 124; Russia, 1 in 127; and Austria, 1 in 150. England follows with 1 in 212; but if the 63,000 regular troops employed in India be reckoned, we have one man under arms for 148 persons of population, or much the same as Austria, where strict economy is necessarily observed.

In America, finally, the proportion is only 1 in 1,500.

The next figure has already been mentioned. It represents the cost per head of the average force under arms in time of peace. The lowest cost appears in Russia and Italy, at £37 and £38 per man; then come three great European Powers, at substantially the same amount, viz., France, £43, and Germany and Austria, £45, per head under arms.

In England, the amount is more than double these last, viz., £93; and in America it rises to the enormous figure of £278 per man per annum. It is strikingly apparent that, even when every allowance is made for the costliness of the necessaries and luxuries of life in England and in the United States, the forces raised in those countries by voluntary enlistment are more expensive by far, if we are to judge by the estimates, than the armies of conscripts raised by the great European Powers: and we must conclude that, if the remuneration offered to the Anglo-Saxon soldier in the open labour market be fair, that which the conscripts are compelled to accept, is *inadequate;* and the balance which is withheld from them, although it does not appear on the face of any budget or estimate, is a virtual tax on the country; —but that bearing of the calculations will be discussed in the second portion of this paper.

The next group of figures gives the corresponding statistics for the war-strength of the various countries, the final line giving the cost in expectation or anticipation, not that of the war strength when fully embodied. These figures are very instructive. The war-strengths show the relative military power of the nations. The number of population per head of war-strength is an index of the pressure of conscription on the population.

In Austria 1 in 30 of the whole population can be placed under arms on mobilisation. France and Germany can produce 1 in 31, Italy 1 in 34, Russia at present is content with 1 in 50, while we have

in England and the colonies, except India, 331,000 available men, or 1 in 96 of the population of the United Kingdom.

It would appear from this that about one-thirtieth of the population is about the maximum force which the great military Powers can place under arms in time of war. If, however, America be an exception under ordinary circumstances, it must be recollected that during the war of secession there were above three and a half millions of men recruited or drafted into the armies on both sides, or one-ninth of the entire population.

The next lines—giving the cost per man in time of peace, of the war-strength; and the ratio which the war-strength bears to the peace-strength—afford a general idea of the economy and efficiency of the military administration.

At this point I have introduced statistics relative to the cost of a private soldier, but the consideration of them will be treated subsequently.

Another group of statistics relative to recruiting is subjoined, giving—The number of males annually attaining the age for military service, which, roughly speaking, is about one-hundreth part of the population, of whom it may be added but one-half are generally found available, the rest being unfit or exempted from one reason or another:—

The number of recruits taken and trained annually, divided into first and second portions of the contingent, the latter receiving only partial training:—

The proportion which the annual contingent bears to the whole population; and the *percentage* of those who come to the military age, who are trained.

And here some explanation is necessary. In England it is assumed that the recruits for the regular Army constitute the first portion of the contingent, and the Militia recruits the second. The volunteer recruits have not been accounted for, nor is the number annually entering the Royal Navy and Marines included. The recruits requisite to maintain the regular forces in India are, however, comprised as a set off. It must also be borne in mind that the recruits passed from the Militia into the line; 4,000 to 5,000 are counted twice.

In other countries the naval contingent has been excluded.

The number of recruits taken in the annual contingent is one of the best standards whereby to gauge the military training of a country, bearing in mind that the first portion are efficiently trained, and the second inefficiently; for the real military strength depends on the number of persons trained, however they may be classified, and by whatever name they may be called. Once a man is made a soldier of, he forms a unit in the military strength of his country as long as he can handle a musket, even though he may be temporarily lost sight of in the civil population. For if an emergency arises, that man can be induced to come forward again, and if the country be in danger there *should* be means, and there always *have been* means on such occasions to compel him.

We enlist annually 20,000 men for the Army (a number which

must be augmented annually in proportion as the new short-service men are passed into the Reserve, and which must ultimately exceed 30,000). The Militia takes 30,000 recruits, of whom 3,000 re-enrol, and 5,000 pass on into the regular Army. There is further a regular loss throughout from desertion, amounting to 15 per cent. in the regular service, or 3,000 per annum, but this is quite certain to diminish from the effect of short service and deferred pay.

It may be assumed that of the whole 50,000 recruits, at least 35,000 may be considered new and reliable, and if we can reckon on the services of those men, whether in the ranks or in the Reserve, for twelve years (Militia as well as regulars) we ought to be in a position to lay our hands on 400,000 trained soldiers in case of emergency, independent of the Volunteers. Those *fish* exist—what we want is a *net* to catch them.

The Militia.

In the tables which I have prepared, the Militia men are not specially dealt with, inasmuch as they have no complete analogy in any foreign State. The cost of a Militia man is easy to arrive at from the data already before us.

The total strength—Officers and men—cost, on the average, £10 per annum, as you may see from the Army Estimates. The private is, perhaps, not so well off as a Line soldier during the period of embodiment: but you must recollect that, under ordinary circumstances, he is far less subject practically to military law and to petty restraints than the Line soldier: he is among his friends and in his own county, and, on the whole, he regards his month's training in the light of an outing.

He is in these respects better off, but it is hardly necessary to say more; as, if the Militia is embodied for any long period, its conditions of service become almost identical with those of the Regulars.

The £10 per head, which has been mentioned as the cost of a Militia soldier, is merely a net sum from the Estimates, and will not compare with the £93 in line 9, Table I. It includes no share of administrative or non-effective services.

There is, however, a financial question regarding the Militia which I shall bring to your notice.

It has sometimes been said, that the same money which is now spent on the Militia would give better results if applied to increase the regular Army and Reserves; and I shall endeavour to show what you can have for your money in other ways. I shall assume that the substitutes are to be *bonâ fide* short service regiments, consisting of a cadre of old soldiers, and the rest enlisted for three years with the colours and nine years in the Reserve, forming four-fifths of the whole.

The cadre of an infantry regiment might consist of 26 Officers, 58 non-commissioned Officers, 40 corporals, and 80 long-service privates—in all 204—with 400 short-service men, coming in at the rate of 133 per annum, and being passed into the Reserve at something

less than that rate, and forming, with their nine contingents, about 1,000 men, when the system was fully at work.

I will not trouble you with calculations, but simply say that, for the £1,200,000 which we pay for 118,000 Militia, you could have 31 such regiments of 600 strong, or 18,600 men and 31,000 reserves, making in all 50,000.

This force of 18,600 men could not, of course, be sent abroad.

Now how does the comparison stand?

You could not have more than 30 or 40 cadres of regiments, whereas now you have 160 in the Militia, and that is a very serious drawback. Would your 50,000 men, of whom three-fifths would be reserves, be so much better than 118,000 Militia? Would they, in short, be more than twice as good?

I believe you will agree with me in voting for the old constitutional force, with the power of the ballot (unfair as it is) behind it.

And here it is well to draw attention to the division of all armies into two classes:—1st. The cadre, formed of the administrative, executive, and instructional portion, and the old soldiers; and, 2nd. The contingent—the recruits—or the rank and file, who are drilled, instructed, and moulded into soldiers by the others; and as soon as they are so trained, they ought at once to be passed into the Reserve. You can have a large cadre and a small contingent of recruits, or a small cadre and a large contingent, for the same strength, and about the same money. In the former case, you have a large number of trained reserves, and in the latter, you may have none at all.

An example will show how this bears on the cost and efficiency of an army.

In France, after the Crimean war, there was a nominal contingent of 100,000 men, which, however, was reduced to 79,000, by those taken for the Navy, those unfit for service, &c., before they became disposable. There were in force all kinds of ingenious systems for evading conscription, by purchase, substitution, replacement, &c. The nation would not submit to the improvements proposed by their rulers. The system of replacement or exoneration was profoundly rooted in the customs of the people. The first portion, 43,000 of the contingent, served for seven years, and the second portion, 36,000, for five months. Of the 43,000 taken annually to keep up the Army, at a nominal strength of 400,000, no fewer than 20,000 at one time used to obtain exonerations, most of them being replaced by the re-enlistment of old soldiers, who received a considerable bounty. The price of a substitute rose in fact to over £80. The consequence was, that the Army was really kept up by only 23,000 conscripts annually at one time, most of whom re-enlisted for term after term, becoming veritable "vieux grognards," while there was no reserve at all.

It may be mentioned in comparison, that the number of recruits which we have taken in England for the regular Army has often surpassed that figure, and that too without a bounty.

They had then in France no reserve whatever of trained troops, and the result was—the disaster of 1870.

Now, instead of taking 23,000 only into the regular Army, they take

108,000, nearly five times as many, to keep up a strength of 440,000, or about 10 per cent. more than in the time alluded to.

That, it must be allowed, is a forcible example of how the number of recruits trained annually indicates the true strength of a nation, and will make it clear how desirable it is to have small cadres and large reserves, instead of old soldiers and nothing behind them.

Yet another instance of the applicability of the same principle of small cadres and large reserves will not be out of place.

The peace establishment of a battery of field artillery in most continental countries consists of 4 guns to a war-strength of 6 or 8. When mobilisation is ordered the reserves come in, horses are requisitioned, and the reserve guns and waggons are paraded with the battery. The number of cadres is the same, but the number of guns is increased by half, or even doubled.

Now turn to our own Royal Artillery. They have an establishment in peace and in war of 6 guns, and the number of guns which we can put into the field can only be increased by increasing the number of batteries—by creating fresh cadres in fact. These new cadres can only be obtained by subtracting men and Officers from the existing batteries. If this *must* be done in war, it *ought* to be done in peace. A battery with a peace establishment of 3 or 4 guns may be raised to 6 or 8, and filled up with trained reserves, without losing its efficiency; but if you take one of the 6-gun batteries, split it in two, and make each half up to full strength with recruits, can you expect these new and unorganised cadres, and these untrained men to drop into their places at once, and be equal to batteries raised on the other system?

It all points to the moral, that to combine economy and efficiency you must have Small Cadres and Large Reserves, and this has a most material effect both on the apparent and on the real cost of an armed force.

The Cost of an Infantry Soldier in different Countries.

Hitherto only general figures have been dealt with; direct and indirect charges accounted for in the Army Estimates have all been massed together; and no distinction is drawn between Officers and men. I have endeavoured to work out the cost of an *army* in different countries, and I shall now try to lay before you the cost of a *soldier*. *Vide* Tables II—VIII.

As it would have been extremely complex to form an average including all ranks below Officers, and all branches of the service, the infantry of the line has been selected as being the backbone and numerical majority of all armies, and I have tried to put a monetary value on the advantages and inducements held out to the recruit on joining. (Table II.) These advantages are of a various character, and may be classed under three heads:—

1st. Immediate and direct advantages.
2nd. Prospective advantages.
3rd. Indirect considerations.

The *immediate and direct advantages* comprise:—

1. *Pay*, ordinary extra pay, and marching money.

2. *Food*, including rations of bread, meat, groceries, liquors, &c., and allowances in lieu thereof.

3. *Clothing*, including uniform, necessaries, boots, &c., and allowances for that purpose.

4. *Barrack accommodation*, and lodging allowances.

5. *Bedding*, furniture and utensils.

6. *Fuel*, for warming and cooking.

7. *Lighting*—candles, oil, or gas.

The *prospective advantages* include:—

8. *Good conduct pay.*

[1]9. Prospect of increased *pay on promotion.*

10. *Gratuities* and presents.

[1]11. Prospect of *deferred pay.*

12. Prospect of *pension.*

13. *Hospital and medical attendance.*

14. *Education.*

The *indirect considerations* are:—

15. Opportunity of earning in private employment while serving.

16. Diminished cost of amusement and travelling.

17. Alteration in social status of the Army.

18. Attractions and drawbacks incidental to military service, especially abroad, including loss of civil freedom, subjection to military law, and restrictions on marriage.

19. Prospect of obtaining a civil appointment on leaving the Army.

20. Risk and mortality in the Army, from war and bad climates.

It is at once apparent that many of these items are of such a nature as to render a monetary appreciation of their value impossible, and yet they cannot be omitted from consideration. The direct and prospective advantages can be calculated, and I have given the results in the table (II) appended to this paper, but only propose to call your attention to the general figures, and these amounts are, I beg you to observe, *absolute* and not *comparative*. It would be absurd, for instance, to conclude that, as a Russian soldier gets £10 per annum, and an American soldier £100, the latter is therefore ten times better off. In order to arrive at a comparative result, the condition of the soldier must be contrasted with that of the class from which he is drawn in his own country.

And here again there is wide scope for differences of opinion. What grades of the social scale are to be included? What are their earnings? Do they pay for their medical attendance and education, and provide for their poor, aged, and infirm? How are they affected by taxation? Are the necessaries of life cheap or dear? Is the climate hot or cold, equable or extreme? What do the inhabitants eat and drink? Are they frugal or luxurious in their mode of living? Is the population engaged mainly in agriculture or in manufactures? What is the value of money?—and a hundred other questions which are quite as difficult to answer as it is to discount the prospective advantage of getting into a theatre at half-price, or deciding whether that privilege is a fair set-off against the chance of having to wear a wooden leg.

[1] I have taken into account the additional inducements brought forward by the Secretary of State for War, when introducing the Army Estimates this year.

It is impossible to integrate all these considerations, many of them trifling in themselves, yet forming an important whole. You can only draw broad comparisons.

The principal is, that voluntary recruiting is apparently expensive. America and England pay respectively more than twice and four times as much for their rank and file as the countries where universal liability to military service is in force. In Russia, a soldier is fed, clothed, and housed, but his pay is so small—about a farthing a-day—that it is hardly worth taking into consideration. He has to serve simply for the necessaries of life. And this is the case to a great degree in the other continental countries—it takes a man his whole pay merely to live; and he is dependent on extra employment, in a civil capacity, on assistance from his family, or on the bounty of his friends, for anything he may have in the way of comfort and luxury.

These contributions form in many countries no inconsiderable part of the income of the soldier.

But the most important point to observe is—that the economy of conscription is not real. If a soldier is worth £40 per annum in the open market, and you only give him £20, you are robbing him of his time and labour to the extent of the £20 you withhold, and you thus impose an additional tax on the State by exacting that sum annually from every soldier you employ, instead of distributing it over the population generally, by an equitable system of taxation.

Part II.

Loss to a country by Conscription.

I shall now proceed to the second portion of the subject, viz., the loss to a country by conscription. It may be urged that there is no loss; but that objection will be incidentally disposed of in endeavouring to assess it. The question is one of evidence, and much of the evidence is based on opinion or even on prejudice. The general effect of conscription is so well described in a memorandum handed in to the Recruiting Commission of 1861, by Mr. Godley, then Assistant Under Secretary of State for War, a gentleman who was well known and highly esteemed by many now in this room, that an extract from that document requires no apology. Mr. Godley says:—

Mr. Godley's Memorandum on the Means of Recruiting the Army.

(Royal Commission on Recruiting, 1861, par. 1796).

"Conscription, which is at first sight and superficially a cheap "mode of recruiting armies, is, in reality, the most expensive that can "be adopted. It is a tax by lot, confessedly the very worst tax that "a Government can impose. Where substitutes are allowed and pro-"vided, the tax is paid in money, and consists of the price paid for "the substitute, the only difference between such substitutes and "recruits, provided as ours are, being that in the former case the

" bounty is paid by the unfortunate individual on whom the lot has " fallen, in the latter case by the public.

" The case is still harder with those who cannot afford to purchase " substitutes; on them the conscription is a tax which takes at one " swoop their whole capital, *i.e.*, their labour and their time. It " matters not what the value of that capital may be—whether they " be skilled or unskilled, educated or ignorant, earning high or low " wages, producing largely or producing nothing, down comes the " relentless conscription, takes possession of them for the best part of " their lives, and gives them in return hardly more than clothing and " food. In these cases the pecuniary amount of the tax is represented " by the difference between the value of the conscript's labour at his " own calling and his pay as a soldier. But no pecuniary expression " can represent the full amount of individual suffering and public " inconvenience which must be the result of so extensive and violent " a dislocation of labour. Compulsory service of any kind would be " peculiarly injurious to a country inhabited by an enterprising and " colonising people like the English. Such a people always sits " loosely to the soil, and the prospect of a conscription would " infallibly lead to a regular and large emigration of our best work- " men, a class of whom we already lose too many. Of course if " there is no other way of getting an army, we must have a conscrip- " tion; but surely everything else ought to be tried before we have " recourse to it."

This is the general view, and a very sound one; but it deals only with the hardships of the system of substitutes on the poor—the system of substitutes, an iniquitous injustice, devised to relieve the rich of their share of the burden.

A substitute is a voluntary recruit, whose bounty, as Mr. Godley points out, is paid—not by the State—but by the unlucky individual who is drawn in the ballot. The fine is the same, whether it be paid by a prosperous millionaire or a struggling artisan. The general practice has been an uniform rate of exemption, based on supply and demand. £40 was not an uncommon price for a substitute for the Militia in the beginning of this century. In France, it ranged up to £150, and the regulation price fixed by the Government was £80. In America, during the late war, the cost of a substitute rose as high as £100 or £200 above the £100 paid as bounty by the State; and if a ballot, with substitution, were resorted to in this country for the Army, it is certain that even these high figures would be exceeded. Now can anything be more unjust than this lottery of fines?

The system admits, it is true, of being improved, by introducing a sliding scale, based, for instance, on income, but the administration of such a method presents immense difficulty, and what after all is the difference between a system of graduated fines, and an item in the budget, for the provision of the sums required, in the annual Estimates? Substitution, then, at its best, is only equivalent to recruiting by large State bounties, a mode universally recognised as vicious.

Let the system of conscription without substitution, be now considered—universal personal service. There is a kind of abstract ideal

justice in it, but in practice it is a mere chimera. No nation ever has, or ever will arrive at the point of insisting on personal service to the last bitter drop.

The law of conscription in these countries which we refer to, invariably begins by declaring universal liability in the most emphatic way, and immediately proceeds to enumerate exceptions, giving privileges or immunities on one pretext or another, to at least half the people who are liable.

The exemptions are grounded on:—

1. Physical causes—as insufficient height or chest measurement, deformity or disease. These are inevitable.

2. Family reasons—as being the support of the family, an only son, having a brother already in the ranks, &c. These are also unobjectionable.

3. Social reasons—as being a minister of religion, a student in specified establishments, a doctor, or professor, &c. This is where the stumbling-blocks commence, I will give you an example. It would be *impolitic* to draft a Cabinet Minister, and it would be *absurd* to impress a bishop. Yet the extension of immunities to such classes as these distinguished persons may be the exponents of—when pushed to the other extreme—is equally ridiculous, for you come down to the postman and the parish-clerk, who, although their absence might be more felt in their respective spheres than that of the higher functionaries in their offices, could bring no equitable or valid reason for exemption on the ground of the duties performed.

These are types of the difficulties which have occurred. I believe the postman, or even any one whom he might employ to carry a letter, evaded the draft in the United States, on the ground of his being a Government servant; and certainly in Italy the embryo ecclesiastics managed to escape until within the last few years.

4. Voluntary service, combined with an educational test.

In Germany, a volunteer for one year passes a high test examination, the number of volunteers being limited; and the system has a most beneficial effect in stimulating advancement in education. In France, however, the spirit of the law regarding one year volunteers has been most disgracefully evaded. The Civil Commissions charged with the examinations, have admitted boys who could do little more than read and write; but this can, of course, be remedied.

In Russia, there is a system which, at first sight, is rather attractive. Those who have received certificates from a first class educational establishment only serve three months. Those with a certificate of the second class serve for six months; and those who can pass a special examination serve for two years. This applies to volunteers only, but conscripts have similar, though not so extensive privileges. The volunteers generally support themselves. Now, this admission of volunteers on an educational test, and on condition of self-support, is really, in a country like Russia, simply in favour of the rich and well to do, and consequently against the poor, who have to make up the numbers.

In Russia, only one-tenth of the contingent can read and write;

so the educated few practically get off altogether, or are made non-commissioned officers after a few months. In Italy, 43 per cent. can read and write; but education there is advancing with rapid strides. Austria is about the same. In France, 60 per cent. can read and write. In England, about 90; but we, too, are improving. Germany is at the head of Europe, with 96 per cent.

Then it must be considered that a great number of the men who are liable for conscription do not put in an appearance, and cannot be found; and of those who are mustered, many are put back temporarily for immaturity, or other reasons; so that the number dwindles down to something very far below what may be expected. In Germany about one-third are found available, in Italy nearly one-half. As an instance of how conscription affects the upper classes, about one-eleventh of the total contingent in Italy were proprietors, merchants, professional men, and students, whose enrolment must be considered as a very large pecuniary loss both to themselves and their country. In Austria, the persons exempted, from whatever cause, pay a fine instead of serving. In Italy, the one year volunteer pays £31 to receive the pay and rations of the soldier. In France, the volunteer pays £36, and the total amount paid by them to the State is 18 millions of francs, or £720,000 in the Estimates for 1876. That gives an idea of the value attached to a reduction of service to one year.

But the real way of ascertaining the cost of conscription is to calculate what recruits could be obtained for in the open market, as volunteers, and to consider the difference between this sum and what they actually receive as the indirect taxation representing what the nation pays in this unjust and unequal manner for submitting to conscription. In France a labourer earns about £29 per annum, and an artisan £37 and upwards. Taking £33 as an average rate to compare with the soldier's £20, we find that the State appropriates £13 from the earning power of each private soldier, and a higher sum from the non-commissioned officers. But it is enough to take the smaller sum.

368,000 men[1] at £13 each, make £4,784,000; and I have already told you that a fine of £720,000 is exacted from the volunteers; so the lowest estimate of the cost of conscription in France, regarded in this point of view, is £5½ millions, or 22 per cent. of the Army Estimates. Let us look at it from another point of view. A substitute used to cost 2,000 francs, or £80, that was the regulation price before the war, but it has often been higher. There were 164,789 recruits to be incorporated in 1876, of whom only 108,000 are to be taken as first portion. Suppose that one-third of these were voluntary recruits, the remaining two-thirds—72,000 men—were fined £80 a head by the

[1]

Total		440,000
Gendarmerie	27,000	
Officers	19,000	
Staff	26,000	
Permanent	72,000	72,000
Leaves rank and file		368,000

State, or something about £5¾ millions, materially the same figure as the last, or about one-quarter of the whole cost of the army.

In these two calculations you will observe that only the labouring classes have been taken into account; and that the losses suffered by men of business, merchants, manufacturers, and persons of large property, have not been considered at all.

This limitation has been adhered to, mainly because the one-year volunteer system affords to those classes a loophole of escape. Yet the damage done to them and to the material prosperity of the country is far greater than is shown in the not inconsiderable sum I have mentioned.

But I must observe that universal liability has undoubtedly an excellent effect on the Officers, for it drives into the Army a number of young men of fortune and high position, who would otherwise perhaps do nothing, but who are glad to become Officers in order to avoid being conscripts. This inducement has hitherto been sadly wanting in France, but I venture to predict that thirty years hence the social status of the French Officer will have materially altered. In Germany the effect has long since been produced. To return, however, to the cost of conscription, I trust that I have made it clear that this 5½ or 5¾ millions in France is not the value of a mere sentimental grievance, but an actual taxation by lot, and a sum which ought to appear on the estimates, which, instead of being as they are 20 millions, should be 26 millions or more, the balance being made up by compelling men to work for three-quarter wages, the State appropriating the remaining quarter.

It is unnecessary to go through the same process for other States; suffice to say that France pays the best, and Russia the worst, that is to say that France appropriates the smallest percentage of the fair earnings of the soldier, and Russia the greatest.

It is a broad fact that all these nations pay their conscripts vastly less than the market rate of their service, and that the difference is made up by indirect means which equally bear upon the country, and are capable to a certain extent of evaluation.

It is urged by the advocates of conscription that it is a cheaper system than voluntary enlistment. Nothing can be more fallacious than to suppose so. If we adopted conscription to-morrow, and only paid men a farthing a day (as is done in Russia), giving them, besides, the mere necessaries of life, there would be an apparent saving of £15 to £20 per man per annum; but that apparent saving is no real gain to the country, it is only a capitation tax on the conscripts which ought to be levied on the country in general. But they say: "You get better men." Undoubtedly you do, but at a loss to the community at large. You take a man who is earning a pound a day, and you give him a shilling or a farthing, and the gross earnings of the country are decreased by the difference between what pittance you choose to accord to him, and the fair remuneration of his skill or talent. There is no economy in robbing Peter to pay Paul, and there is no justice in compelling Paul to work for one-twentieth part of the wages he can obtain in the open market.

Conscription is only justifiable when the necessities of the country compel its Government to develope its military resources to the fullest extent—when it becomes necessary to train the great bulk of the able-bodied population to arms—as is now the case with most of the great Powers. If every available man is taken at a certain age, there is at least no injustice to individuals, although the higher classes suffer far more than the lower.

If even a moiety of the available men are taken, there is but small ground for complaint. But it is entirely different when you only want, as we do, a very small proportion of them, and that small portion for exceptionally arduous duties, which they are quite ready to insure themselves against if the premium is small, as it would be in England.

I am sure that the notion of sending a conscript to the West Coast of Africa, or even to India, can never be seriously entertained. In short, we never ought, and never will, apply conscription to recruiting except for the Militia, and then only as a *dernier ressort*.

The question of economy in military administration, as a consequence of conscription, can never come into operation in this country. We *must* raise the wages and inducements to enlist voluntarily, *pari passu* with the cost of living and the demand for labour; and when the moment comes for enforcing conscription, it will be impossible to turn round and say to your conscripts—we do not intend to pay you as much as a volunteer, although we admit you are worth more. There can be no saving then in that way.

On the contrary, it is most probable that every reasonable addition will have been made to the inducements to enlist, previous to conscription, and these cannot be immediately withdrawn.

As the question of conscription for our own Army has been already ventilated within these walls, I shall only remind you that, in addition to the objections and injustices which surround it in other countries, we should have to superadd our Indian and Colonial service—banishment, most likely to an unhealthy climate. That single condition is sufficient to render conscription for the regular Army, as now constituted, impossible. No minister could venture to propose a measure which would render the population liable to exile as well as to compulsory service, for it is beyond a doubt that we have never had a difficulty in obtaining men for those arduous duties, which could not have been avoided by some foresight and a little money; and which was in fact got over, without even the suggestion of resorting to such an iniquitous injustice as conscription for Indian and Colonial service would be.

I must remind you, moreover, that during the struggle for existence in America, during which 3,700,000 men were under arms on both sides (about one-ninth of the entire population), there was *no* time that a substitute could not be procured, although the price sometimes ran very high. It was enthusiasm and patriotism which brought the best men in America into the army, and not the compulsion of the draft; and I venture to say that those motives are by no means extinct in this country.

Conscription may in some cases be an inevitable necessity, but viewed in any aspect is a costly injustice, and the fewer the men required in proportion to those liable, the greater is the unfairness to the unfortunates who are drawn. As we have no intention of training the whole population to arms, the necessity for resorting to conscription for the Army seems remote; but our previous experience of the working of the existing law for militia-ballot ought to be a warning to us to advocate such alterations in the Act as will make it really efficient if it ever has to be put into operation, for it is now lamentably out of date, and is universally admitted to be unsuitable.

I shall only add a hope that the system of *small* cadres and *large* reserves may render a resort to conscription unnecessary. There are plenty of men to be had at the market price, and if John Bull wants more, it will be cheaper for him to put his hand in his pocket in time of peace and maintain a reserve, than to resort to a levy of raw recruits on the outbreak of a war.

APPENDIX.

TABLE I.—*Statistics relating to the Cost of Armies in different Countries.*

		England. 1876.	France. 1876.	Germany. 1876.	Russia. 1874.	Austria. 1872.	Italy. 1873.	America. 1875.
1	Population	31,628,338	36,102,921	41,000,000	85,685,945	35,904,435	26,801,154	42,000,000
2	Gross annual expenditure	£76,966,510	£103,000,000	£87,000,000	£79,000,000	£73,000,000	£60,000,000	54,000,000
3	Taxation per head of population	£2 7 0	£2 17 0	£2 2 0	£0 18 0	£2 0 0	£2 5 0	£1 6 0
4	Gross Army estimates	£14,485,300	£20,000,000	£19,000,000	£25,000,000	£11,000,000	812,000	7,600,000
5	Cost of Army per head of population	£0 9 0	£0 11 0	£0 9 0	£0 6 0	£0 6 0	£0 6 0	£0 4 0
6	Percentage of total taxation spent on Army	·19	·19	·21	·16	·15	·13	·15
7	Average number under arms—peace establishment	150,000	440,000	419,000	675,000	238,000	217,000	28,000
8	Head of population to one man under arms—ditto, ditto	212	82	98	127	150	124	1,500
9	Cost of Army, all ranks, per head—ditto, ditto	£93 0 0	£43 0 0	£45 0 0	£37 0 0	£45 0 0	£38 0 0	£278 0 0
10	Average number under arms—war strength	331,000 ex. ⅔volunteers.	1,150,000 ex territorial army.	1,315,000 ex Landsturm.	1,686,000 ex irregulars.	1,137,000	770,000	
11	Head of population to one man under arms—ditto ditto	96	31	31	50	30	34	
12	Cost of war strength in time of peace, per head	£42 0 0	£17 0 0	£14 0 0	£15 0 0	£9 0 0	£10 0 0	
13	Ratio of numbers—peace strength to war strength	2·20	2·61	3·14	2·50	4·77	3·55	
14	Ratio of cost—peace strength to war strength	·45	·39	·31	·40	·20	·26	
15	Pay, rations, clothing and housing a private of Infantry	£37 10 0	£21 0 0	£17 16 0	£10 4 0	£13 1 4	£15 8 3	£97 5 0
16	Prospective advantages enjoyed by a private of Infantry	£18 11 0	£5 1 0	£7 7 5	£1 5 0	£7 11 2	£5 2 6	£11 8 8
17	Total cost of an Infantry soldier to the State	£56 1 0	£26 1 0	£25 3 5	£11 9 0	£20 12 6	£20 10 9	£108 13 8
18	Wages of a labourer	£40 0 0	£29 0 0	£30 0 0				
19	Wages of a tradesman, artisan, or mechanic	£65 0 0	£37 0 0					
20	Number of males attaining military age each year	280,000	300,000	480,000	800,000	337,000	250,000	400,000
21	Annual contingent of recruits, 1st portion—Regulars	20,000	108,000	.. .. ..	.. .. ..	89,000	50,000	
22	2nd portion, or Militia	30,000	56,000	.. .. ..	.. .. ..	58,000	35,000	
23	Total recruits	50,000	164,000	149,000	150,000	147,000	85,000	4,000
24	Proportion of annual draft to population	1 in 632	1 in 209	1 in 275	1 in 566	1 in 244	1 in 315.	1 in 13,500
25	Percentage of men attaining military age who are trained	·18	·55	·31	·19	·43	·34	·01

TABLE II.—*Estimate of the Pay and Allowances, Direct and Prospective Advantages, of a Private Soldier in the Infantry of the Line in various Countries.*

	IMMEDIATE AND DIRECT ADVANTAGES.	England.	France.	Germany.	Russia.	Austria.	Italy.	America.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1	*Pay*—Ordinary extra pay and marching money	18 10 0	7 4 7	9 7 1	0 10 10	2 3 10	.. .. ..	33 10 0
2	*Food*—Rations of bread, meat, groceries, and liquor	11 3 2	7 19 9	2 16 0	6 3 8	6 14 7	14 0 0	37 15 0
3	*Clothing*—Uniform, boots, necessaries, and allowances	4 2 5	3 11 8	3 0 4	1 14 6	1 18 10	.. .. ..	12 0 0
4	*Barracks*—Lodging or allowance	2 12 0	1 8 7	.. ..	.. .. ..	1 10 0		
5	*Bedding*—Blankets, sheets, straw, furniture, utensils	0 2 5	0 8 6	2 12 7	1 5 0	0 8 7		
6	*Fuel*—For warming and cooking ..	1 0 0	0 6 11	.. ..	.. .. ..	0 2 6	1 8 3	14 0 0
7	*Lighting*—Candles, oil, or gas	..	.. ..	.. ..	.. .. ..	0 3 0		
	Total A ..	37 10 0	21 0 0	17 16 0	10 4 0	13 1 4	15 8 3	97 5 0
	PROSPECTIVE ADVANTAGES.							
8	Good conduct pay	1 4 9	1 18 0	1 0 0	*	0 16 9	*	*
9	Increased pay on promotion	5 10 0	1 6 0	1 6 0	0 2 0	0 11 0	0 9 0	6 0 0
10	Gratuities and presents	0 5 0	*	*	0 2 6	*	*	*
11	Deferred pay	2 10 0	Nil.	Nil.	Nil.	Nil.	Nil.	2 5 0
12	Pension	7 4 3	0 19 7	4 0 0	*	4 14 9	4 5 4	1 0 0
13	Hospitals and medical attendance	1 7 0	0 14 9	0 19 4	1 0 0	1 8 0	0 8 2	1 13 8
14	Education	0 10 0	0 2 8	0 2 0	0 0 6	0 0 8	*	0 10 0
	Total B ..	18 11 0	5 1 0	7 7 5	1 5 0	7 11 2	5 2 6	11 8 8
	A + B ..	56 1 0	26 1 0	25 3 5	11 9 0	20 12 6	20 10 9	103 13 8
	INDIRECT CONSIDERATIONS.							
15	Opportunity of earning in private employment	Insignificant.	Moderate.	Good.	Very considerable.	Fair.	Fair.	*
16	Diminished cost of amusement and travelling ..	Nil.	..	Very	ry appreciable.			Nil.
17	Alteration in social status	Negative.	Improved.	Greatly improved.	Improved.	Improved.	Improved.	*
18	Attractions of an adventurous career	Considerable.	Very	small in all these	countries.			
19	Prospect of civil employment	Nil.	Good.	Very good.	*	Fair.	Fair.	
20	Risk and mortality from war and bad climates	Considerable.		Very small,	except in great nat	ional wars.	..	Small.

TABLE III.

ENGLAND.

Cost of an Infantry Soldier.

Army Estimates, 1876–7.

	Per diem.	Per annum.
	s. *d.*	£ *s.* *d.*
Vote 1. Pay	1 0	18 5 0
„ Additional pay (future)	0 2	3 0 10
„ Good conduct pay and skill at arms .. £ 97,000 / 70,287	0·8	1 4 9
„ 10. Provisions ..... 1,368,000 / 122,500	....	11 3 2
„ Paillasse, straw ..... 14,730 / 122,500	....	0 2 5
„ Fuel and light, half of ..... 233,130 / 122,500	....	1 0 0
„ Lodging or barracks	....	2 12 0
„ 11. Clothing, rank and file	....	3 1 5
„ Great coat, leggings, gloves, and necessaries..... 131,000 / 195,000	....	0 14 0
Share of free kit on joining	....	0 7 0
Vote 4. Hospital and medical attendance and medicines .. £262,000 total vote. / 195,000 Army and Militia.	....	1 7 0
Education ..... F G H 61,400 / 122,000	....	0 10 0
Chelsea and Kilmainham ..... 26,000 / 122,000	....	0 4 3
Out-pensions ..... 1,220,000 / 185,000	....	7 0 0
		50 11 10

TABLE IV.

FRANCE.

Cost of an Infantry Soldier from French Army Estimates, 1876.

	Francs.	£ s. d.
Pay	150 38	6 0 4
Wine, beer, spirit	4 70	0 4 0
Marching money	1	0 0 10
Necessaries' fund	36 50	1 9 2
Supplement	29 20	1 3 5
Gross pay	221 78	8 17 6
Deduct hospital or furlough	22 17	0 17 11
Net pay	199 61	8 0 0
Clothing	53	....
Provisions (see below)	..	2 2 2
Lighting	5 36	0 4 3
Hospitals	19 70	0 14 9
Bedding	10 62	0 8 6
Maintenance of arms	1 60	0 1 4
Fuel—warming and cooking	8 60	0 6 11
Pensions borne by finance estimate and mainly caused by the war 66,000,000 × £430,000	15 30	0 12 9
Ecoles regimentaires $\left\{\frac{1{,}388{,}000}{430{,}000}\right\}$	3 23	0 2 8
Invalides $\left\{\frac{696{,}000}{430}\right\}$	1 62	0 1 4
Secours $\left\{\frac{3{,}332{,}000}{500{,}000}\right\}$	6 66	0 5 6

France, 1876, p. 754, cost of Rations to State.

	c.		Per annum. £ s. d.
750 grm. bread	·22	26c. is deducted from pay, leaving extra cost 13c.	6 19 0
300 grm. meat	·39		
Sugar, coffee	·11 7		

Extraordinary or field rations.

Rice and salt ·02 Brandy every three days ·07	.....	1 7 0

One year Volunteer pay 900 francs.

Table V.

Germany.

Cost of an Infantry Soldier from Estimates, 1876.

	Marks.	£	s.	d.
Pay of a private	126	6	6	0
Allowances in garrison	61	3	1	0
Bread ration	56	2	16	0
Clothing and equipment	60·3	3	0	4
Barracks, fire, and light	30·5	1	10	6
Additional ditto	2·1	0	2	1
Hospitals and medical staff	19·3	0	19	4
Education of privates, &c. $\left\{\frac{£\ 639{,}000}{311{,}000}\right\}$	2·05	0	2	1
Invalid houses $\left\{\frac{£\ 425{,}000}{311{,}000}\right\}$	1·4	0	1	5
	358·7	17	18	9
Pensions not in Army Estimates.				
Mean prospect of increased pay on promotion	26	1	6	0

	Marks.		Marks.
Lowest pay	10·50	per month =	125 0
Mean pay	12·7	„ =	152 4

The daily bread portion is 750 gr. 1·5 pence is deducted daily from the soldier's pay for his mid-day meal. If this is insufficient a supplement is issued calculated on the cost of provisions.

Ration—Small.	Large.
150 gr. raw meat	250
92 rice	118

or certain equivalents in meal, vegetables, potatoes, &c.

A fuel ration is for a room holding from 4 to 8 men. A room for 12 men receives 1½ rations. A ration is $\frac{1}{150}$th part about of a klafter of wood.

Oil is issued to rooms for the winter months, 12 loth in all per annum.

Privates have 40 lbs. hay or 65 lbs. straw per annum for bedding.

TABLE VI.

AUSTRIA.

Estimated Cost of Infantry Soldier.

Estimates 1871.

	Gulden.	£	*s.*	*d.*
Menage	44·2	4	8	4
Brot	22·21	2	4	5
Kasern-Servis	4·37	0	8	8
Betten Stroh	·73	0	1	5
Zusammen	71·51	7	3	2
Betten Nachschaffung	2·11	0	4	2
„ Ausbesserung u. Reinigung	1·50	0	3	0
Montur und Rüstungs-Gebühr	19·40	1	18	10
Löhnung	21·90	2	3	10
Feuer-Gewehr-Reparatur	·53	0	1	7
According to Estimates	116·95	11	13	11
Sanitätswesen $\left\{\frac{3,137,106}{224,000}\right\}$	14	1	8	0
(There are 5 per cent. in hospital at a cost of 123 g. per head.)				
Versorgungswesen $\left\{\frac{10,623,183}{224,000}\right\}$	47·4	4	14	9
Invalid Hospitals and Pensions.				
Unterricht—Ausbildung	·33	0	0	8
	178·68	17	17	4
Unterofficiers-Dienstes-Prämien	8·4	0	16	9
Prospect of increased pay	12·	1	2	0

Bread rations—black bread—875 grammes, costs 1·6 pence.
Meat ration 185 grammes.
Tobacco at reduced price.

TABLE VII.

ITALY.

Cost of an Infantry Soldier.

Estimates 1874.

	Lire.	Lire.	£	*s.*	*d.*
Daily pay (*soldo*)	·43				
Bread money	·25				
Service allowance (*assegno individuale*)	·14				
Deconto (includes clothing, boots, &c.)	·14				
	·96	350 40	14	0	0
Corpo veterani ed invalidi — 1 251 000 / 195 000	....	6 43	0	5	4
Servizio sanitario — 1 907 300 / 1 95 000	....	9 77	0	8	2
Pane e viveri (included in pay) — 22 713 000 / 1 95 000	....				
Letti, legna, lumi, casermaggio — 4 247 000 / 195 000	....	21 70	0	18	1
Transporti materiali, &c. — 1 919 000 / 195 000	....	9 80	0	8	2
Immobili — 575 000 / 195 000	....	3	0	2	6
Pensions — 195 000 000 / 195 000	....	100	4	0	0
		501 10	20	2	3
Arms Accoutrements					
Cost of Levy	....	....	0	10	0

A one year Volunteer Infantry pays 620 lire and receives pay, clothing, &c., as a soldier.

The Estimates calculate the average cost per man under arms (not including works and buildings, &c.), at 700 to 900 lire per annum.

Bread ration 941 grammes. Costs 2·2 to 2·4 pence. Meat ration 200 grs.

Tobacco at reduced price.

Levy of 1873, 65,000 (1st.) 35,000 (2nd.)

Total number dealt with		273,751
Rejected under 5′ 1″	21,603	
Deformed or diseased	49,979	141,350
Only male, eldest son of widow, and other family reasons	69,768	
Remaining to be drawn from		132,401

TABLE VIII.

AMERICA.

Cost of an Infantry Soldier.

	Dollars.	£	*s.*	*d.*
Money pay—average	180	36	0	0
Additional pay $2 per month after 5 years.				
Bread, meat, and groceries	168	37	15	0
Clothing	60	12	0	0
Lodging, fuel, and light—Est.	65	13	0	0
Bedding	....	1	0	0
Hospitals free—Est.	3·40	0	13	8
Medical attendance, say	5	1	0	0
Education, say	....	0	10	0
Asylums—Pension, say	....	1	0	0
		102	18	8

Reputed cost of a soldier £200 or 1,000 dollars per annum.

One dollar per month is kept back as reserved pay and handed over in a lump at the end of 5 years. 60 dollars = £12. The effect has been to diminish desertion.

No Pensions allowed, except in cases of disabilities from wounds and other causes incurred on duty.

Commodious asylums provided for old and disabled soldiers.

Colonel Lord WAVENEY, A.D.C., F.R.S.: I am quite sure, Sir, that you will not think I am anticipating a very pleasant duty that falls upon you when I express the satisfaction with which we must all have received the statements made by the lecturer on this occasion, and if I take exception to some few of his inferences, and permit myself to supplement some of his statistics, he will, I am sure, believe I do it in an earnest desire to co-operate with him. In the first place as a Militia Officer myself, I thank him for asserting the principle of small cadres and large reserves, as compared with the system of a small concentrated force as alternative to a large expensive body. There are some points of consideration also with regard to that service. The service is capable of much larger expansion than is usually understood, even with the present disqualification of the high price of labour which necessarily draws away so many. Having commanded a Militia-regiment for many years, I have had an opportunity of testing the materials from which we draw our recruits, and I find that in the agricultural districts, to which alone you can look for a permanent supply, the rural population is diminishing to a certain extent, and only that portion who cannot obtain engagements for the whole of the year, come to us in the Militia. There is no doubt an arrangement by which it is possible to have the three months' training of the recruit in the winter months instead of his being called up, as was originally the case, when the men were under arms for training. This expedient was adopted in the brigade I have under my command, and as to the result, it was taken advantage of by a fine body of young men,—the finest I have seen since entering the service—comprising those who could not find subsistence during the whole of the year, and who therefore were presumably more likely, this being an agricultural district, to be out of employment in the winter than in the summer. Those three-month men will be dismissed to-morrow. During the winter, we employ them in drill and in gymnastic exercises, and I must say, after twenty years' service, I never saw a body of soldiers of three months in better trim. There is another point with regard to recruiting for the Militia and the ballot. It is not generally known that in remodelling the Militia Acts of 1853, a power was reserved in supplement of the voluntary enlistment—that is to say, the Militia service is told off for recruiting into divisions and districts in each respective county, and a certain number of recruits is alloted to each. But if this number be not obtained by voluntary enlistment, there is a power to ballot under the Act to raise the determinate number of Militia soldiers. At the present time it is unnecessary that we should revert to that course. Very fortunately the principle of small cadres, well carried out in the Militia-service, is amply sufficient, and indeed I am inclined to think if we came to verify the particular proportions of men enrolled in each Militia regiment, we should find the cadre system was practically and fairly and absolutely adopted. If it be well developed, I will answer, from my own experience, for making up the full strength and establishment of the regiment, so soon as there is prospect of so much of garrison and foreign service as we were permitted to undertake during the Crimean War and the Indian Mutiny. And now I would go to the point of conscription for the army in the country which has carried it, as I think, most beneficially into effect. I have returned recently from Italy. The conditions of Italy are peculiar. The Army is a necessity of constitutional existence, and to maintaining a place in the European system for the Italian people, so much so, that it has become with them a proverb, "The Army made Italy by its battles; the Army will make the "Italians by its education." The conscription in Italy,—and here to a certain extent I venture to differ with the lecturer—is carried out absolutely without exemption, except of course such as are necessary and consistent, that is to say, not to take the widow's son, or the support of the family, or professional men. A very remarkable occurrence has recently taken place. The Italian government has met with exceeding obloquy because it insisted that the pupils at the universities or seminaries for educational purposes should not be exempt from service in the ranks. It was discovered that this was evaded, and that Italians passed off into the foreign universities without serving. At last it was decided that what we should call an undergraduate must take his turn of service in the ranks, but there was the means of shortening the period by joining the one-year engaged soldiers. Therefore they are as much subject to conscription, only they have to learn their duty in

a shorter time, saving the money of the State, but in a term which probably, considering their superior education, will be quite sufficient to enable them to acquire the habits of the soldier, amongst whom they live in barracks, whether in separate "chambrès" I do not know, but they do duty as private sentinels. With regard to figures, I am not inclined quite to agree with the lecturer, either as regards America or Italy. The most clear, definite and accurate detail of the operations of any army that I have the good fortune to know, was that which was presented by the War Minister for America—I think Secretary Stanton—the year after the close of the great struggle. It has also this advantage, that it was not a collection of estimates and figures, but of results, and of expenditure. With regard to Italy, through the kindness of the Parliamentary authorities, I obtained a larger amount of Parliamentary information presented on the part of the War Minister to the Committees of Parliament, and from Committees sent back to the Chamber of Deputies than those of any country, not excepting the English Blue Books which have puzzled so many of us. The Italian has a natural genius for analysis; he has a power of diving to the very bottom of a subject, which is perfectly marvellous; and inasmuch as the great question for Italy is for the present her army, the government has gone deep in research into military subjects; they have accumulated every historical fact that can bear upon the question, and have thrown light on a great many points of which we were ignorant. For instance, is any student of German history acquainted with the principle on which the great Frederick paid his officers? He sought them far and wide in whatever country, and for their speciality; he employed and paid them highly, and this is exceedingly remarkable,—he seems to have made separate payments to the individual, and in cases of artillery and cavalry officers he gave pay in those days to the troop officer in those arms equivalent to the double pay of a captain in the British service in India at the present moment. A remark has been made as regards the proportion of revenue expended on the army, varying from 13 per cent. in Italy to 20 per cent. in Germany. In these cases I think the revenue should be set against expenditure generally and subdivided afterwards, attributing so much to the different arms, so much to fortification, so much to office expenses, and so on. I have tables on these matters in my hand, and they are quite at the command of the lecturer in case of discrepancy.

Now with regard to the conscription itself. An army is a constitutional necessity in Italy, because Italy says thus:—"We will have no invasion on our frontiers; we "will invade none; we will be drawn into no entangling alliances. Italy for the "Italians! The Army made Italy; the Army will make the Italians." The Army has thus become a necessity, and the most permanent arrangements have been made for the purpose of giving Italy an Army such as she desires. And here is the fair side of conscription. When I discussed conscription with the highest military officer in the country and those nearest the throne, the remark made was, "A "conscription is possible for us, but it would be unfair for you, because with your "Indian and Colonial service you could not send a conscript out of the country." That shows the principle on which conscription is understood in Italy. The country is divided into districts so that the soldier is as it were amongst his fellow provincials, and is not harshly thrust amongst those with whom he may have no affinities; but the regiments are kept separate in the districts, and when the soldier is once placed in the regiment he is sent to any part that may be necessary. The soldier is taken as a youth, and this is the difference between the conscription of this Italian country and others, that he is taken as a youth, he is worked as a youth, he is sent back immediately his work is over to his parish (I am speaking of the infantry soldier), and is not then drawn upon for the period during which he is liable to conscription, unless in case of war. What is that period? Twelve years, during which he is liable to conscription, and three years, or, practically, two years and eight months, during which he is with the colours, and he is then returned to his own home. Being taken as a very young soldier indeed, he comes into the condition of my militiaman of whom I spoke, who has not obtained a position in trade or business, from which being displaced, he encounters a serious loss. A scale has been made for the force that can be calculated upon from 1872 to 1885. I take three decennial periods, and I find 90,000 men; 65,000 immediately join the colours, 25,000 are sent home and drawn upon during the three years to repair the loss

which is rather under 10 per cent.; consequently, at the end of three years the 90,000 are exhausted, and this is the result:—in 1872, 381,300 with the colours, and 250,960 at home, and in 1884, 576,000 with the colours and 191,000 at home, making 767,000, which is to be the normal state of the future available army of Italy, and which may be mobilized in a fortnight.

Colonel ROBERTSON, late 8th King's Regt.: I never heard read in this Hall, I have never saw reported in the Journal of this Institution a more able and instructive paper than that which we have just had the pleasure of hearing Captain Ardagh read to us. The facts he has collected are most valuable; I may say they are indispensable for any one who wishes to investigate thoroughly the problems of military organization. Very few Officers wishing to obtain such information as is contained in Captain Ardagh's paper, would know where to find it, still fewer, if they knew where to search for it, would have the perseverance and the analytical skill to extract from voluminous official documents, the data required for such exhaustive summaries of results as Captain Ardagh has not only tabulated for us, but which he has also commented upon with a masterly clearness of statement which could not be surpassed. For in the long paper with which he has favoured us, I do not think there is a single ambiguous sentence which requires explanation, or a single obscurely stated fact, respecting the significance of which, any gentleman present will feel it necessary to ask a question.

As regards the conclusions of Captain Ardagh, I regret very much to find that an Officer whose opinions are certain to be regarded as authoritative, is an opponent of the policy of exacting military training, and the liability to military service as a duty.

I entirely differ from Captain Ardagh, and from all those who think that compulsory military training would be hurtful either to the private interests of the individual citizens of this country, or to the political and industrial interests of the state. I say compulsory military training, not compulsory service, because the effect on individual and political interest of exacting the performance of military duties for a short period is totally different from the effect of exacting this duty for a long period. I regard military duty exacted for a short period (say one year) as a highly beneficial educational training, but if exacted for a long period (say five or even three years), I regard it as a most onerous and pernicious servitude.[1] In considering the question,—is, or is not compulsory military service beneficial? the answer altogether depends on the length of the period for which the recruit is required to serve. If for a short period, it will be beneficial, if for a long period it will be injurious both to the interests of the recruit and of the State. Conscription, that is military servitude for a long term of years, may, perhaps, without much exaggeration with reference to individual interests, be described, as it is described in the words of the late Mr. Godley, quoted by Captain Ardagh,—"A tax by lot, which takes from the "conscript at one fell swoop his whole capital, *i.e.*, his labour and his time."

But a short term of compulsory training has a very different effect. A law imposing such a duty so far from diminishing the capital of a labourer would increase it, for, although during the year of training the pay he would receive from the State would be less than the wages he might have earned, I do not consider it correct to describe this difference between the recruit's pay and the labourer's earnings as a pecuniary loss and an unjust tax imposed on the recruit. On the contrary, I look upon the sum representing this difference as capital very profitably invested, as money laid out in an educational training, the equivalent and much more than the equivalent of which will be increased vigour both of body and

[1] I regret that Captain Ardagh did not include in his paper some statistics respecting the military organization of Switzerland. Should the Government of that country ever consider it expedient or necessary to render compulsory the performance of some part of the military duties required for national defence, I am inclined to think that some modification of the military institutions of Switzerland would be found better suited to the social and political condition of England, and therefore better adapted to serve as our model, than the military institutions of Germany, France, or Italy.—A. C. R.

mind, increase of money-earning power, increased chances of obtaining profitable employment.

This view of the effect of a short term of military service is in accordance with the views of General Trochu,[1] and of Sir Charles Trevelyan.

Sir Charles considers that to a young labourer military training is as great, even a greater advantage than university training to a young man intended for a professional or political career. If this be so then, that statesmen who shall pass a law exacting from every Englishman the duty of one year's military training, so far from imposing an unjust tax or an intolerable burden on the people, will confer on every labouring man in England a most valuable boon, a benefit of very real and practical kind. Time will not permit me to say more respecting the manner in which a law rendering military training compulsory would affect the social and individual interests of the community, but I shall endeavour to indicate in a very few words what I think would be the effect of such a law on the political interests of the State.

During long periods of peace, influences are at work which give an undue predominance to the special selfish interests of individuals, and which are often adverse to the general interests of the community.

These influences have a disintegrating effect on that combination of political forces, which constitutes a vigorous national life. They are inimical to all institutions and organisations requiring the sacrifice of private interests for the public good; and having for their object to render the individual will and all the abilities of every citizen subservient to the purposes of the State, and instrumental in carrying out its policy. As an extreme and almost ludicrous instance of the sacrifice of the interests of the public (or at least what the Government believe to be the interests of the public) to the selfish interests of a few individuals, I may mention the successful resistance of the insignificant section of the community engaged in the manufacture of lucifer matches to the financial schemes of a minister remarkable for the determination of his character, and belonging to a Government which commanded a large Parliamentary majority and the confidence and support of a powerful party in the State. Another striking instance of great political power, entirely under the control of individual interests, is afforded by the very effective, though not entirely successful, resistence of the publicans and brewers to the recent legislation for regulating the liquor traffic. The political effect of a measure rendering military service compulsory would be antagonistic to the predominance of selfish feelings and interests as motives of action, and to those tendencies of the existing condition of political forces in England, which are opposed to national organisation, to the centralisation of the powers of Government, and in general to the attainment of all objects which require unity of purpose and combined action.

I have to apologise for the length of these observations, but I trust they will not be considered as either superfluous or irrelevant. The considerations I have endeavoured to present have not been discussed by Captain Ardagh; perhaps the scope of his paper did not require him to notice them. It might, however, have been expected that either the author of the admirable essay on "recruiting," to which the prize medal of the Institution was awarded, or else some of the Officers who took part in the discussion which followed, would have pointed out that the institution of a system of compulsory military training would be attended with great social and political, as well as with very great military advantages. As, however, this was not done either by Captain Hime or by any of the speakers, whose observations are reported in the Journal of this Institution, I have availed myself of this opportunity to endeavour to direct attention to those considerations, which, if ably advocated and thoroughly discussed, will, I feel convinced, lead to the conclusion, not merely that we must be prepared to accept as an inevitable military necessity, a measure rendering compulsory a universal training to arms; but much more than this, that we should recommend and endeavour to promote by every means in our power its voluntary adoption, because we confidently believe that with

[1] *Vide* the chapter headed "Jeunes et Vieux Soldats" in l'Armée Française en 1867.

reference to the civil and political, as well as to the military interests of the nation, such a measure is in all respects expedient and very desirable to establish this conclusion, and if possible to render it popularly acceptable. This is a task which I hope will be undertaken by some member of this Institution who has more authority to command attention, and more ability to convince and persuade than I have. Captain Hime is reported to have said, "I am not in favour of conscription, I only point out that whether we like it or not, it is inevitable." I am by no means sure that conscription is inevitable, but I am quite sure that conscription, if adopted, whether from necessity or from choice, will certainly be very beneficial; that if once established among us, it will be cherished as one of the most valuable of our national institutions.

Captain FEATHERSTONEHAUGH, R.E.: I only wish to say two words. There appeared to me to be an inconsistency in Captain Ardagh's argument. He says, "If "you have voluntary enlistment you have to pay the market price; if you have "compulsory enlistment you do not actually pay to the man, but the State loses it "in another way, so that it is six of one and half a dozen of the other." I do not see that the argument has any weight. I do not agree with the second conclusion that the State has to pay that difference between the market value and the wages of the soldier indirectly. It is often said there is nothing so fallacious as figures. I believe that is true. The real question is, can the State afford to have 100,000 men idle every year? and if you look at it in that point of view I think it can. The labour market is over-stocked; men are emigrating; if there were 100,000 soldiers idle every year besides those who go abroad, wages would only rise slightly, and I consider a thickly populated country like England can afford to have a number of men idle every year. I shall be glad to hear any more explanation of Captain Ardagh's theory, because it is to me a stumbling-block I cannot get over.

Mr. RALPH KNOX, War Office: I do not wish to enter upon a discussion as to whether conscription is the best course for this country to adopt, but rather to congratulate the lecturer upon the delivery of this most important and interesting lecture. I do not think he has really raised the question as to whether conscription is advisable or not. He has wished to inform this Institution, and through this Institution the public, for which I feel certain that this Institution and the public will feel very grateful, what he has found after most elaborate inquiry and study, to be the relative cost in money of the soldier in the various countries of Europe, and what he considers to be in money the cost of conscription to the individuals who are conscribed. I think he has stated with remarkable clearness in his lecture, and with even more clearness in the Tables attached to it, the facts as to these matters, and I can only say that I thank him very much for the information which he has prepared. The department to which he belongs may congratulate itself as bringing forth this very excellent fruit as one of the results of its institution. The lecturer has been enabled from the position which he holds, to analyse many facts and figures, which, until very recent years, were hardly accessible to one individual; he has studied them thoroughly and has laid them most clearly before us. He has, in the course of his lecture, criticised in a very small degree, and therefore I am not inclined to join issue with him, the way in which some statements are made in the statistics which are laid before the House of Commons in this country. But I may say in explanation, that these departments are not able to do as they like in laying figures before Parliament; there are rules that guide them, rules that restrict them, which they in many cases would be willing to cut through. This is not possible, as the rules in many cases are of great value to secure the objects in view. The figures in the estimates state in the most clear and accurate manner all that can be stated as a forecast of the expenditure to be incurred for the Army in this country. It is quite true other nations go into more elaborate details in their figures, but those figures are by no means exact. What we do want, however, in this country is a clear and exact return of past facts. We want clear and exact statements as to what has been done with our money. We do not seem to take an interest in these things, but such statements are really at the root of all true economy. Very few people know it but nevertheless it is the fact, and if more care were taken in laying the monetary facts of the past before the country, I am sure it would tend to vast saving of military expenditure. I do not wish to occupy your time any further, but

conclude by thanking Captain Ardagh very much indeed for the very elaborate and clear statement of the cost of the armies of Europe which he has laid before us.

General Sir WILLIAM CODRINGTON, G.C.B.: Every nation has its own characteristics, and one of the characteristics of the English nation is a desire for the absence of compulsion. With regard to conscription, it is my impression that it is the most expensive, the most tyrannical proceeding with regard to families and to individuals, that can be adopted by any nation. Look at the extreme detail of supervision that goes on—I do not know whether in France it is to the same extent—but which is enforced in Prussia; not only is the individual taken, but I think I am right in my impression, that the family is made answerable for the man being forthcoming in his village when he is wanted. I ask you to carry that into the detail of English life and judge what it would include. There is another consequence in Prussia which shows the extent to which it is necessary to go in this extreme of compulsion, viz., that if a man is lame and not fit for service, they make him pay in money as they naturally say "It is not the fault of the State that you "are lame, we cannot admit that you should be freed from the necessities of con- "scription except by paying." That is another result of rigorous conscription. My general impression certainly is, that unless you are under the pressure of invasion, or of such an attack elsewhere that your last defence would be by fighting abroad, you will never get conscription in England; I believe it would be better worth while paying to the utmost, than it would be to take every individual of every class to do that, for which I believe you will get men better suited to your purpose by volunteering. With regard to a proposal for conscription in England, it was said by a Secretary of State for War, "that the Government preferred paying for "the labour they required." If we really did so pay for the labour we required, we certainly should get the men. It might be a very costly business, but I believe in the end it would be more economical to the nation generally than that extreme compulsion which would be necessary for conscription.

E. B. DE FONBLANQUE, Esq.: I entirely agree with the last speaker, that the English instinct is so completely against conscription that it would be almost impossible to introduce it in this country. The tendency of the Essay has been to establish that, upon financial as well as upon political grounds; but I think Captain Ardagh has rather lost sight of the differences in the institutions of other States, owing to which the system which is not admissible by us, is perfectly admissible in other countries.

Captain ARDAGH: I only spoke of England as regards conscription; I offered no opinion whatever about conscription in other countries.

Mr. DE FONBLANQUE: You gave illustrations on the subject.

The CHAIRMAN: Illustrations as to cost—as to the working of it.

Mr. DE FONBLANQUE: Well, as to the working of it. The lecturer spoke of the exemptions under the law of prescription as being very unfair. Now, in some countries these exemptions are next to nothing. In Switzerland, for instance, there are hardly any exemptions whatever. Then, by way of contrasting the advantages of voluntary enlistment with conscription, he has quoted the civil war in America, and has alluded to the patriotic feelings that induced them to come forward, until almost the whole population may be said to have been absorbed into the Army. But the fact is, nearly one-half of those Armies consisted of foreigners, principally of Germans. (Captain ARDAGH: No, no.) Probably I exaggerate when I say one-half, but I do not think I am very far wrong. As I said before, however, I entirely agree with the lecturer, so far as the question is confined to England, and as to conscription not being capable of defence on financial grounds, which the lecturer has fully and ably established.

Captain GURDON, R.N.: I just wish to speak a few words to confirm the last speaker. Fully one-third of the men in the Northern Army were foreigners—either Germans or Irish, and if the Southern States had been able to have blockaded the North, the North would not have been able to have kept up the war the length of time they did. One whole division of General Sherman's Army were Germans, and so far Germans that they could not even speak one word of English. About one-third of the Army of the Potomac were Irish and Germans. I beg to state, I have

got my information in the United States itself, where I was travelling and residing for two years and a-half; and I got my information, not only from Southerners, but from United States Officers as well.

The CHAIRMAN: Were they naturalised Germans?

Captain GURDON: They were not; they were men who came over during the war. There were special agents from the United States in Germany, and also in Ireland, and these men were ostensibly sent over for railway works, but, in reality, they were all, when they arrived at New York, enlisted, given large bounties, and took the place of Northerners who ought to have served in the Northern Army, but could not be got to serve. I would also beg to state, with reference to Captain Ardagh's statement that the cost of the American Army is so enormous and its pay so large, is perfectly correct, and, notwithstanding that very high pay, it is not possible to find sufficient native-born Americans to enter the ranks; nearly one-half (which you will admit is a very large proportion for the Army of any country) consists of foreigners, German and Irish chiefly, at the present moment.[1] I think that fact will dispose of one of the subsequent speaker's remarks that, if you pay your men very highly you would *always* get them, because in this case the American Government cannot get a sufficient number of their own citizens to serve in the *ranks* of the Army. That depends, indeed, on what opening there is for the civil population. If the civil population can make a great deal more money by civilian pursuits than they can in the Army, and there are greater openings, of course naturally, in countries like America or England, you cannot get your men. The same thing was apparent here during the Crimean War, when we could not get sufficient recruits, although we were offering high bounties, and we had to raise a German legion, an Italian legion, and a Swiss legion,[2] and, if the war had gone on two years longer, half our actual Army in the field would have been foreigners. My remarks were caused by Captain Ardagh's statement that, in his opinion, both this country and the United States could rely on voluntary enlistment to sustain the strain of a serious war; I do not think that actual facts tend to confirm that statement.

Captain ARDAGH: I expected to have thrown an apple of discord among the audience in raising this question of conscription, and am very much obliged for the remarks which have been made on the paper, and in particular for the statistics which Lord Waveney has given with regard to the Italian Army. But I must say, with reference to his remarks, that he drew his statistics from a prospective table, whereas I took mine from actual facts and returns, which the Italian Government gave. There is really no material difference. As regards exemption on educational grounds in Italy, the principle on which it is carried out is very little different from that which is enforced in Germany; the test is somewhat more severe than in France, but the principle is much the same in all. Colonel Robertson has called attention to the advantage of military training as compared with an university education, for which, he suggests (it may be considered) a fair equivalent.

Colonel ROBERTSON: It was Sir Charles Trevelyan's opinion.

Captain ARDAGH: I think Sir Charles Trevelyan has rather over-estimated the advantage of a year's training in the ranks.

Colonel ROBERTSON: I quite agree with him, but I quoted him.

Captain ARDAGH: One might set-off against that advantage, supposing it is an advantage, the great loss which persons who earn large sums in private employment would be subjected to in being withdrawn from their occupation for a year: and I really think if you appeal to the country, that any notions entertained as regards the advantage which the youth of the nation might derive from compulsory military training would never meet with the slightest response from the great bulk of the population, and it is quite useless to propose such a thing. The objections that Captain Featherstonehaugh has raised with regard to conscription have been virtually

[1] This is excluding the negro troops, my observations only applying to whites throughout. There were about 60,000 negroes during the war in the Northern Army; at the present moment, I believe, there are about 4,000 in the United States Army.

[2] Not to mention the Turkish contingent.

answered in the paper. I do not allege conscription is not cheap; if you judge by the annual Estimates, it is cheap according to this standard. You have in France 20 millions as the nominal cost of the army, but I have shown you it costs that country at least 26 millions, and I believe it costs over 30 millions. It is unreasonable to say that because they only pay 20 millions for what costs the country 30 millions, they are gainers thereby. I am deeply obliged for the compliment which Mr. Knox has paid to these statistics. No one is better able to offer an opinion on that subject than he is; but I must beg him to consider that in criticising the form in which the British Army Estimates are presented to the country, I only intended to impugn them in so far as that they make it impossible for any one to discover, except by the most minute investigation, what a soldier really does cost; and if I were to ask Mr. Knox now what would be the cost of adding a new division to the British Army, I venture to say he would find it almost impossible to procure data to answer the question. Sir William Codrington, I am glad to hear, adds the weight of his authority in opposing conscription. As regards Mr. De Fonblanque's observation with reference to service in Switzerland, I venture to submit that it can hardly be brought in as an example. Military service in Switzerland is merely an amusement: the great bulk of people who go out for their short annual training in Switzerland regard it much in the light of a picnic. There is hardly such a thing as military law in Switzerland; they are subject to but slight restraints and no hardships. With regard to America, it has been asserted that one-third of the whole armies in America were not naturalised American citizens. From the returns that are published, it appears that one-ninth of the population of America were under arms during that war, and I ask you if it is possible that one-third of that one-ninth could have been foreigners? It is simply preposterous; the thing is disposed of by the mere fact that one-ninth of the whole population were under arms. To tell me that 3,700,000 men were one-third composed of foreigners in America during the war is to make an assertion that won't bear any inquiry at all.[1]

In conclusion, I beg to thank the meeting for the interest with which this comparatively dry subject has been received.

The CHAIRMAN: Gentlemen, I think you will all agree with me that we are greatly indebted to Captain Ardagh for this most valuable contribution to the records of this Institution. It is by papers such as these that the character of the Institution stands, and will rise. Before sitting down, I would venture to make a few observations, as the subject of the paper is one which, as Captain Ardagh has said, I have studied a great deal, and it is one also concerning which I have before spoken in this room. I quite agree with Sir William Codrington, that you must take into consideration, in debating this question, the circumstances of the country to which it refers. What is a necessity—an absolute necessity—on the Continent, is happily for us not a necessity. Foreign Governments have to deal with the the necessity which has been imposed upon them, and they deal with it according to their respective lights, and in that way in which they consider it will be least onerous upon the populations they govern. The latest law, at any rate, the last that has come to my knowledge, with regard to conscription, is the new law of service in Russia. It is based on the same principles as the German law—that all the population, including now the nobles who were formerly exempt, are liable to

[1] The annual number of able-bodied male emigrants (about one-fifth of the entire number) was, during the period 1860–70, 90,000. If every available man of these had been drafted into the army on landing in the country, the four years of the war could, as a maximum, have only produced 360,000, or one-tenth of the number mentioned, instead of one-third as alleged. The estimated number of naturalised citizens residing in the United States is 4,136,000, of whom 3,100,000 are Irish or Germans, the total population being 38,558,371. The number of able-bodied men would amount to about one-eighth of the whole, or 500,000, so that both sources of supply would fail to make up one-third of the whole. As a matter of fact, the largest proportion of recruits was furnished by the Western States, which had no means of procuring immigrants as substitutes. Kansas sent 36 per cent. of her men to the field, Iowa 30 per cent., Indiana and Illinois over 25 per cent. The Confederate States had, of course, no means of recruiting by immigration, in consequence of the blockade.

military service, and therefore to conscription. The Emperor, in the Edict in which he publishes this law to the country, congratulates himself and the country on the readiness with which those classes who were previously exempt from conscription have fallen into his views, and accepted this law; but when you come to look into the operation of the law, you find exemptions of the most marvellous character; all people who have properties to manage are exempted; all people who are in the Government service, and not only those in Government service, but those even who are in the service of any corporation are exempt, and have their names registered as such. In fact, the exemptions are countless; and as if they were not sufficient to accommodate the favoured classes, there is a clause under which the military authorities may give to every man who has not acquired the honourable position of a non-commissioned Officer a furlough, or, in other words, may place him at once in the Reserve, which is tantamount to exemption. Having lived in Russia for some years, I conceive the practical working of this law will not tend to promote high morality in the country. With regard to conscription, notwithstanding the many objections attending it, one cannot help admitting it has some great advantages. Germany has reaped the benefit of those advantages to the full extent, because it has been in operation for many years: and amongst them, perhaps, the greatest benefit that has accrued to Germany is that of having promoted education. I have myself seen on the frontier, as you cross from the German provinces into the Russian, the most marked difference between the state of the people on different sides of the conventional line which divides these provinces, for in many places it is merely a line, and not a river nor a geographical boundary; on one side you will find people in the grossest ignorance, and on the other side they have already arrived at a fairly high state of education; you see it in the better cultivation of farms, and in the manufactures which are to be found along the frontier. I have heard intelligent people in that country attribute this difference to the effects of conscription; the population—labourers, artisans, and poor farmers, and that class of people—know, on being drawn into the Army, that they have to come back to cultivate their farms, and earn their livelihoods in their own country, after their three years' service in the ranks. They therefore use their wits, and, acquiring enlightened ideas among a much more civilized people than themselves, bring the knowledge they have attained in those provinces where they have served, chiefly the Rhine provinces, to their own. And so, I conceive, practical education has been equalized to a very great extent over Germany; that is one advantage gained by conscription, as it has been worked in Germany, and as has been proved by the figures adduced by Captain Ardagh, who stated that 96 per cent. of the population read and write, whereas we stand next on the list of educated people at 90 per cent.

I think we are greatly indebted to Captain Ardagh for a point which he has proved most convincingly in this paper, that the cost of an army to a country is not to be estimated by the pay that is given to the soldier, but by the value of the labour that is lost to the country. This being the case, if your army is 200,000 strong, it matters not whether you give the men a farthing a day, as the Russians do, or a shilling a day, as we do, the cost to the country is the same; it is the labour of 200,000 pairs of hands lost to the productive energies of the country. The 200,000 men may be labourers or artisans, the only difference is, that the higher you go in the social scale, the greater the cost to the country. I think we are greatly indebted to Captain Ardagh for having brought this fact out so strongly and convincingly. But while the cost of conscription is the same to the country, it is very different to the individuals who bear that cost. Instead of conscription being an equal tax—I coincide with every word of that valuable extract from a report by Mr. Godley, which was read by the lecturer—it is, I believe, the most iniquitous tax that can be in its working and in its incidence upon individuals; and although on the Continent it is a necessity, I should be exceedingly sorry to see it introduced into this country. I also think the ballot for the Militia very nearly as objectionable as it would be for the Army. For what is the ballot? It means conscription; it is merely the method of selection by which the conscript is drawn into the Militia. If, as would be necessary if the ballot were to to enforced, the Government of this country were to attempt to pass a law by which the infant

would be watched from the cradle up to manhood, and never lost sight of, there is not a mother in England who would stand it. Then you have the total denial of all liberty to transfer oneself from one place to another, or to travel abroad. For the last year before the age of conscription arrived, you would almost want to place a sentry over every man who had to be conscribed ; that is my belief. Such being the case, I should like to make an observation upon a remark that dropped from Colonel Robertson, and I allude to it because it contains a fallacy which is very common in this country on the part of those who admire compulsory service, who say, "Why "not take a man for a year." Colonel Robertson said, he should like to see all the able-bodied men in England under arms for one year. Of course, that would involve our keeping up a separate standing Army for the Colonies and India. The number of males attaining military age each year upon whom this duty would fall, is 280,000; now if you make a liberal deduction, say 30,000, there would remain a standing Army—mind, it would be a standing Army, because they would be so for each year in succession—of 250,000, in addition to our Colonial and Indian Armies.

Colonel ROBERTSON :—I think the lecturer estimated the number actually available at about one-half.

The CHAIRMAN : That is available after exemption as practised on the Continent, but of course if you call men for a year and keep them at home, you will have to get rid of the law of exemption, and I think if you had the power and were to apply the law of exemption in this country, with all our liberal ideas and inconvenient questionings in our Houses of Parliament, you would never be able to carry it into effect. The law of exemption very often degenerates into a means of getting exemption by interest, or possibly some other means, not only most objectionable, but most demoralizing. I think it is a point which some people often lose sight of, that short service for everybody involves a very large standing Army ; and, as the lecturer has shown, 250,000 men, whatever their pay might be, would cause an equal deduction from the productive labour of the country. There is only one other point upon which I wish to make some observation, because I do not quite coincide with the lecturer, and that is his calculations and deductions as to the effect of men being drafted from the Army into the Militia, from which he infers that it would be necessary to reduce our cadres. I do not think that is at all necessary. My idea is that men should be drafted from the regular service into the reserves, and after keeping in those reserves enough men to fill up your service battalions, the balance, as well as those who have served their full time in the reserves, may be drafted into the Militia. The result would be that, instead of having partly and imperfectly trained soldiers in the Militia, you would still have the same number of cadres, but composed of men who had passed through the regular Army and been trained for a certain period, had acquired habits of discipline, and been instructed in their duties.

It only remains for me to ask you to give your thanks to Captain Ardagh for his very valuable and interesting Lecture.

THE NAVAL PRIZE ESSAY, 1876.

ON THE BEST TYPES OF WAR-VESSELS FOR THE BRITISH NAVY,

1STLY. FOR COMBINED ACTION;
2NDLY. FOR SINGLE CRUIZERS OF GREAT SPEED;
3RDLY. FOR COAST DEFENCE.

By Commander GERARD H. U. NOEL, R.N.,
Prizeman, Junior Naval Professional Association, 1873.

"SEGUITANDO SI GIUNGE."

INTRODUCTION.

THE difficulty of the subject of this essay is such, that the most scientific men in the country have failed to arrive at any unanimous conclusion as to what are to be the types of the men-of-war of the future.

The individual opinions already collected are most valuable, but the desirable number of such opinions is unlimited, and all opportunities for giving them publicity, such as essays of this kind, are exceedingly useful in opening up the subject.

Designers and shipbuilders, among whom we find many most able and scientific men, have had in the last few years a difficult task to perform in order to satisfy the requirements of the nation and to keep pace with the enormous and rapid changes in the construction of vessels and in the manufacture of machinery.

The building of vessels-of-war is an art, in which perfection cannot be attained without great and varied experience, and consequently without vast financial expenditure.

Hitherto, the construction of ironclads has not been altogether satisfactory. After all the experience of the last fifteen years, during which time ironclad after ironclad has been built, we still find ourselves unable to arrive at a conclusion as to which is the most satisfactory type.

The Committee on Naval Designs of 1871, were in favour of the "Devastation" class, and also advocated vessels of the "Hercules" and "Vanguard" classes, though opinions were divided as to which of these two types should be followed. Many members, no doubt, foresaw that the days of *all* these ships were numbered, but the time was not ripe for the great changes I now advocate.

Reviewing our present Navy, we cannot but feel proud of its great strength, and of its undoubted superiority over that of any nation, or even of any other two nations. Our ships are not only numerous but well-built, powerfully armed, and admirably equipped. But, grand as our fleet is collectively, it is not satisfactory to observe, that of all the types represented therein, few can be truly called the recognised types of the future, and these few are types of minor importance.

Still, little advanced as we are in the construction of ironclads, other nations are far behind us.

The French, who are noted for their skill in shipbuilding, would probably have kept pace with us (under the guidance of such an able man as M. Dislère) but for the Franco-German war. Next to our Navy, theirs is the most numerous, but their new ships are comparatively few.

The Germans are steadily advancing: they have an ironclad fleet in process of construction consisting of eleven ships, viz., two heavy frigates of the "Hercules" type; the "König Wilhelm" (5,900 tons); two smaller vessels of an older type; three turret vessels (4,118 tons); and three corvettes and sloops. We can, however, learn nothing from these types.

The Russians have one turret vessel (9,662 tons) "Peter the Great," built after the plan of the "Devastation;" one large frigate the "Sevastopol;" one moderate-sized frigate, and six small frigates; three corvettes; and ten gunboats; besides these, three floating batteries, two of which, circular in form, I estimate highly, and mention in Part III.

The Turkish ironclad Navy consists of two 9,000-ton frigates, very powerful vessels (with 12-inch armour at the water line, and 10-inch plating elsewhere); four moderate-sized frigates; eight corvettes; and five gun-boats.

In these various Navies we find some exceedingly powerful ships, most of which are English built; we cannot, therefore, hope to learn as much from the experience of foreign nations as from our own. Englishmen are, and I trust ever will be, pioneers of the science of shipbuilding.

While completing this essay, a catastrophe occurred, which has caused a great controversy on our subject, and has given rise to many opinions as to the necessity for a change in the construction of our ironclads, I allude to the sinking of Her Majesty's ship "Vanguard" by the ram of her sister ship the "Iron Duke."

This accident, while proving the awful power of the ram, strengthens my arguments in this essay, and points to the inexpediency of building such costly vessels, so wanting in floating power as to sink when casually wounded.

Part I.

On Ships required for Combined Action.

For the convenience of discussion, I will divide the sea-going ironclads of the present into *seven classes*, and for this purpose shall

follow the plan suggested in an admirable article on the "British Navy," which appeared in *Blackwood's Magazine*, of March, 1871.

It is an open question whether the ships of the "Devastation" class are to be included under the heading of "ships required for combined action," or under that of "ships required for coast defence;" until more thoroughly tested as to their sea-going qualities, I should prefer giving them a place in a future chapter.

The first class as represented in *Blackwood*, consisted of the "Hercules" and "Sultan." To these will be added, as they are completed, the "Alexandra," "Téméraire," "Nelson," and "Northampton." Undoubtedly these are the most formidable ships-of-the-line now in existence. The "Hercules" and "Sultan" have been thoroughly tested and are found efficient as sea-going ships. They combine fairly protected water-line and battery, heavy guns delivering their fire in all directions, with great speed and handiness, which carries with it a most terrible power of ramming.

The drawback to this class of vessels is their enormous cost; and when we consider that the explosion of one skilfully-directed torpedo would sink the largest of them, and that the thickness of their water-line armour is insufficient to resist a 9-inch chilled shell (thereby exposing their most vital parts to danger), we cannot bring ourselves to believe that the expenditure of over half a million sterling for each vessel, has brought its adequate return. Besides this, the "Sultan" has the defect of excessive top-weight (to counterbalance which, 600 tons of extra ballast have already been put into her): and, indeed, in all these vessels, the fact of protecting their batteries with heavy armour, is, in my opinion, a questionable principle, for by so doing, the size of the battery is curtailed, and the ship is rendered crank; whereas the same weight of armour judiciously placed elsewhere, would make the ship less crank and unsinkable by artillery.

The second class, represented in the above-mentioned article, includes the "Audacious" and her five sister-ships, and the "Monarch," as a sea-going turret ship. The first six of these, though powerful vessels, are generally considered failures. Insufficiently plated at the water-line, overburdened with heavily armoured box-batteries above the upper deck, their first trial proved them so excessively crank as to be wholly unseaworthy. This last evil has been rectified by an increase of about 400 tons of ballast. They are now efficient ships of war, but not of a type likely to be increased in number. The "Monarch," in her peculiar province, is a magnificent vessel. As a ship-of-the-line she is only a few degrees less valuable than the "Hercules," and would be subject to the same objections. But this is not the "peculiar province" referred to. Where she would excel, is in heavy weather, under circumstances where ramming power would be of least advantage, and that of working guns easily in a sea-way, invaluable. The height of her turrets above the water, though a disadvantage in a smooth sea, is an immeasurable gain in a gale of wind —as she is wonderfully steady in a sea-way.

The third class includes but one sea-going ship of deserved repute, the "Bellerophon." She was the first of that type which may be

considered as the most successful, and which is now represented by the larger vessels described as Class I.

The remaining ships of this, and those of the four subsequent classes, are so far out of date that no reference need be made to them in this essay. It may be observed that there is one vessel (on the stocks) to which I have not referred. That vessel is the "Shannon," now being constructed at Pembroke on an entirely new principle.

"The "Shannon" is to be a vessel of 5,000 tons, with a belt of 9-inch armour 9 feet wide at her water-line, extending from the stern to 60 feet from her bow; across the ship at this place a 9-inch armoured bulkhead is constructed, 25 feet wide, reaching above the upper deck. On each side of the ship this extra width of armour extends 26 feet from the bulkhead aft, thus forming a citadel in the fore part of the ship well protected against fire from ahead, and which affords protection to the Officers directing the ship. Above the water-line armour-belt, and aft the bulkhead, a $1\frac{1}{2}$-inch plated deck is constructed. Before the bulkhead, the armoured deck is 5 feet below the water, and slopes down to 10 feet at the stem. I will not say I wholly coincide with the principle on which this ship is built; but it is the only approach to what I deem necessary for ironclads or ships-of-the-line.

We require for "*combined action*" moderately heavy ships-of-the-line, able to hold the sea in any weather and for any length of time, possessing heavy batteries of at least 16 guns, ram-bows, a speed of 14 knots, the most efficient turning-gear, and the water-line thoroughly protected with armour, especially from before the boilers to the stern.

For the leading ships of divisions, it might be advisable to add a protected conning-tower, so that the important duty of conducting, or leading portions of the fleet could be carried on with greater facility. From an offensive point of view the ram is an indispensable arm; and for its full utilization, as well as for defensive purposes, the thorough protection of the motive and directing power of the ship is an imperative necessity.

The first consideration for vessels of this class is, that they be thoroughly "*seaworthy*." I do not mean "seaworthy" in the ordinary acceptance of the term, but that a man-of-war should be possessed of a reserve of "*floating power*" that would enable her to be still seaworthy in a crippled state, or after rough handling in action. To effect this, excessive top-weight must be avoided; and I am convinced that the only course is, to abolish the armour-plating for the protection of the battery.

To render an armoured man-of-war efficient as a floating body, it is imperative that she be as unsinkable as possible by artillery; and that her engines and steering gear (motive and directing power) be preserved so intact during an engagement, that the power to evade all attacks of ram and torpedo is secured. To attain these objects, an impenetrable system of armour at the water-line is necessary.

To provide against possible injuries by ram or torpedo, the ship must be divided into water-tight compartments, a few of which may be filled without danger of her foundering. Great difficulty is experienced in arranging these water-tight compartments satisfactorily,

owing to the immense space required in the body of the ship (her most vital part), for the engines and boilers.

Fore and aft, as well as athwart-ship bulkheads, should be placed where it is possible, so that a wound caused by a ram or torpedo would only fill a comparatively small space, and the floating power of the ship would, though reduced, be able to keep her from sinking.

In addition, I would suggest that all these ships be built on the cellular system "with double bottoms;" and that if some method were adopted in the construction of the bottom, by which the shock of a torpedo's explosion would be cushioned, an immense advantage would be gained. This might be effected by the outside skin of the ship being covered with layers of india-rubber, or some elastic substance, the outside of which would be covered with a thin iron sheathing so fixed as to give to an increased or sudden pressure. Another help in the floating power of a wounded ship, would be to use cork for filling the double bottom; this would cause the inner skin to be of some support to the outside of all, when under extra pressure; and if the outer skin were pierced, the cork would still supply its full floating power.

The second consideration is the "*motive and directing power.*"

I would make it compulsory that all ships-of-the-line should be capable of attaining a speed of 14 knots on the measured mile; an excess of this I deem unnecessary. But as the speed of a squadron, or of any number of ships manœuvring together must be regulated by that of the slowest ship, nothing could be more detrimental to their evolutionary power than to have a laggard amongst them.

It is to be questioned whether in vessels for this service double-screw propellers are desirable. The advantages of this method of propulsion are more apparent in large coasting vessels requiring small draught. The benefit of two separate sets of engines wherewith to propel the ship is universal; but in a sea-way the double-screws often prove dangerous, for by the sudden immersion of the weather-screw by a heavy roll to windward, a ship is liable to be thrown off into the trough of the sea. It is quite possible that this was an element in the causes which combined to bring about the awful disaster of the loss of H.M.S. "Captain."

As regards the influence of this system on the turning-power of ships, the *pros* and *cons* are fairly balanced in the smaller vessels required for coasting; but in larger ironclads the advantages are reduced.

With a ship-of-the-line turning at the high speed necessary for manœuvring, the fact of stopping or backing one propeller checks her way; a loss not counterbalanced by the slight extra assistance in the movement of turning.

In considering the turning-power of these ships, we must bear in mind that we are dealing, as Jurien de la Gravière so truly says, "with masses of six or seven thousand tons, which cannot come in "contact without mutual destruction." Now in vessels constructed with single propellers, the rudder is the sole instrument for turning, and it can be thoroughly relied upon; but with double engines the

slightest want of exactitude in the change of speed might lead to serious results, and any sudden accident to one engine would, in a squadron, probably entail some fatal catastrophe.

The "Hecate," or one of her sister-ships, when coming from Plymouth to Portsmouth, for the "Shah" review in 1873 (in company with two or three other vessels of her class), was observed to run off in a direction at a great angle with her course. This was afterwards found out to have been caused by some slight error in the management of her engines.

H.M.S. "Captain" also on one occasion, when cruizing with the squadron, unexpectedly left her station abeam of the flag-ship and charged through the fleet, narrowly escaping a collision with the Admiral, which would probably have been attended with fatal results.

Against these objections must be set two reasons, which strongly weigh in favour of double screws. One is, that there being no screw-aperture the rudder-head can be made to enter the ship below the water-line, thus admitting of the steering gear being worked out of the reach of shot. The second is, that a greater speed than that estimated has been got out of well-immersed double screws, the "Devastation" attaining one and half knots more than was expected of her. My personal opinion is in favour of single propellers, but these two advantages go a long way to shake my prejudice against double screws. Some trials have been lately made in the gunboat "Bruiser" of a casing round the screw, which proves a useful protection for fixed single propellers. It not only reduces the vibration, but prevents the screw from being so easily fouled; and at the same time has no detrimental effect on the speed of the ship.

All ironclads of this type should be full rigged ships, and should be capable of using sail under ordinary circumstances. In war-time all upper spars and spare gear should be landed.

I must now refer to the turning and directing power of ships-of-the-line.

It appears to me that for ships with single screws, the balance-rudder of Her Majesty's ship "Sultan," fulfils nearly all the requirements so far as power is concerned, and that in this ship (owing to her drawing several inches more water than was originally intended), the rudder is fairly protected. This is not the case in most of our ships, for not only is the armour round the stern at the water-line inadequate protection, but in many cases the upper part of the rudder is actually visible in smooth water. This is a great weakness, as the importance of the rudder is such, that its destruction in an engagement would entail the destruction of the ship.

It is my impression that if it is practicable to place both the rudder, and the steering gear to be used in action, entirely below water, the safety of the ship would be doubly secured.

I would suggest that it is possible, in ships with single screws, to support the upper part of a rudder by means of a horizontal iron strap secured to the ship's counter, and passing round the aperture of the screw (leaving room for its revolving), and that the whole of this

SINGLE SCREW IRONC

Shewing posi

Scale 33⅓ F

Fig 1.

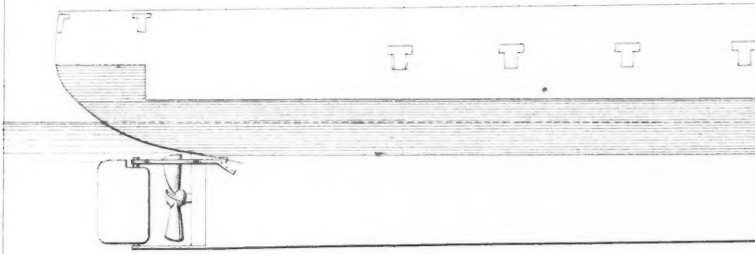


Fig. 2 *Rudder of this Ship worked from t*

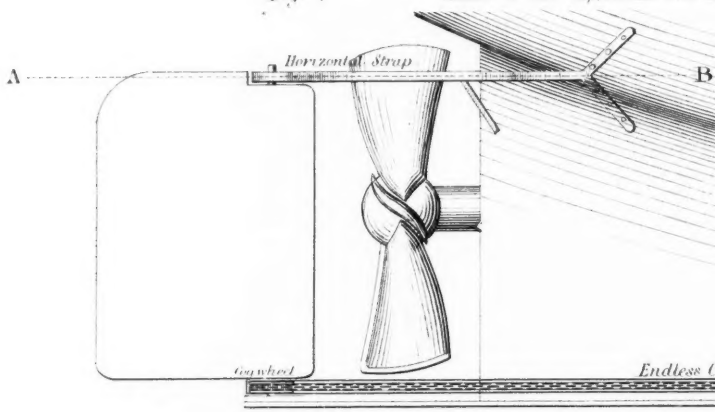
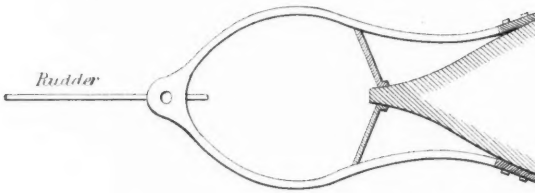


Fig 3. *Section through A.B*



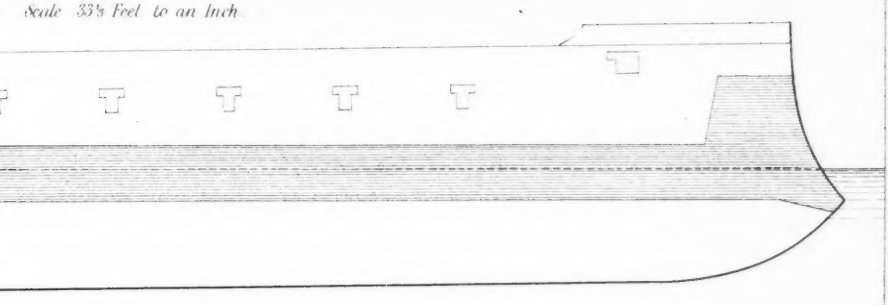
Shewing upper surface of Horizontal S
Scale 8 feet to an Inch

W IRONCLAD OF 5,000 TONS;

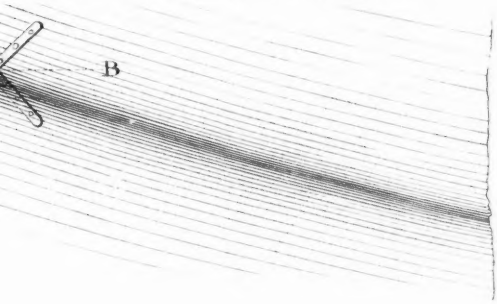
Plate I

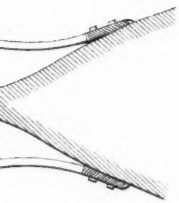
Shewing position of armour.

Scale 33⅓ Feet to an Inch



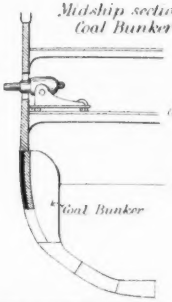
worked from lower end. Scale 8 feet to an Inch





f Horizontal Strap
Inch

Fig 1. *Midship section shewing position of Coal Bunker and double bottom*



Scale 33⅓ feet to an Inch

structure might be at least six feet below water. Then comes the difficulty of steering gear. I cannot see why the rudder should not be moved from its lower end with perfect ease and with the utmost security. Imagine a cog wheel at the lower extremity of the rudder, just above its pivot, and an endless chain round that, and round another cog-wheel of the same dimensions: this latter cog-wheel would form the lower end of a perpendicular spindle passing up into the ship 20 or 30 feet before the body-post. I have endeavoured to show this in Plate I, figs. 2 and 3. For ships propelled by double screws, the protection of the rudder is much more easily arranged. Nothing could be more perfect than the construction of the rudder and steering gear of Her Majesty's ship "Inflexible." The rudder-head enters the ship about 10 feet below the water-line, and the yoke and steering gear are worked entirely below the protection of an armoured deck. I would suggest this system for all vessels propelled by double screws.

The third consideration is the "*armament.*" The ram-bow is an arm which influences the whole method of building the ship to a very great extent. Numerous as are the ships with ram-bows, it is astonishing how they differ in shape. I have no doubt that the next naval action will prove which is the most formidable. It appears to me that the ram of the "Minotaur" class is too round (or there would probably have been a fatal accident in Belfast Lough, when she touched the "Bellerophon,") whereas the rams of the "Bellerophon," and "Lord Clyde," also those of the "Devastation" class, (although these latter are well supported by the additional beam of the ship, and consequent thickness of their root) are too long, and are liable to be strained or even broken, in striking a heavy vessel that is crossing their bow at any speed. I would, therefore, content myself with the formidable and beautiful curves now seen in the bows of the newer ships, and first adopted in the building of Her Majesty's ship "Hercules."

The new idea being carried out in the bows of the "Shannon," and of the "Inflexible," of having a movable snout supported on each side by a fore-and-aft web, I cannot think will answer; such extreme sharpness is not required, and a comparatively slight pressure on one side would break the movable part off. It is true the bow is still left intact, though were the ship to ram again, she would greatly damage herself and do comparatively little harm to the enemy.

To many, no doubt, it may appear that I attach too little importance to the value of guns. My opinion of the present ironclads is, that they are so built that they cannot be sufficiently armed; and, indeed, many of our other vessels might carry a greater weight of armour than they do at present. I would have vessels constructed on the principle alluded to, of "*unarmoured batteries*," to carry half as many guns again (of the same calibre), as ships of their own displacement carry now. This would combine a powerful though unprotected battery, with a perfectly sea-worthy vessel possessed of great speed and turning power, thoroughly efficient under the most aggravated circumstances. The idea of plating the whole of the upper works has long

been abandoned as impracticable, and in the latter ships a confined place in the centre has been moderately armoured for the protection of a battery of guns. By dispensing with this battery armour, the size of the ship is the only limit of the place for guns. This is an undoubted advantage; and when we consider that the whole weight of the battery of Her Majesty's ship "Hercules," including the allowance of ammunition and projectiles, &c., does not exceed 640 tons, about $\frac{1}{13}$ of her displacement, I am sure that the feasibility of increasing the weight to 1,000 tons would be entertained, if the space was not limited, and the armour of the battery could be dispensed with. My plan then is to increase the armament and thus make it of more importance, arming vessels of 5,000 tons displacement with ten 9-inch 12-ton guns, and seven 8-inch 9-ton guns, or a total weight, with ammunition, of about 600 tons of armament; and arming vessels of 7,500 tons with ten 10-inch 18-ton guns and seven 9-inch 12-ton guns, making the total weight of armament about 880 tons. This last armament would be the heaviest carried by any sea-going ironclads.

In these ships *all* the heavier, and four of the lighter, would be broadside guns, two of the lighter would protect the bow and also fight on the beam when necessary, and the remaining one would defend the stern.

The manner of placing the guns is arranged no doubt with a view to their use in action, under the probable system of attack to be adopted: it is my impression that too great a value was attached by some of the authorities, two or three years ago, to bow-fire; and that the manœuvring of a fleet in action, will be more for the purpose of using the ram effectually, and the guns in broadsides on passing the enemy. The battery will thus have the greatest opportunity of being effective in a general action. This is explained in a chapter on guns, in a Prize Essay written on naval tactics in 1873. Such was the high estimate entertained of bow-fire that in several of our ships the bow-armament has been made heavier. The Italians have gone to the length of reversing the order of things, in the "Palestro," (their last ironclad), and instead of a centre, they have a bow- and stern-armoured battery, the centre of the ship remaining unarmoured. I believe this will prove a mistaken or false principle.

In dividing the guns along the whole length of the deck (besides giving more room for working), there would be the additional advantage of decreasing the evil of the moral effect produced by the bursting of a heavy shell in the battery; which if in a confined space would not only be more fatal, but would possibly create a panic, and certainly great confusion; besides placing the whole of the guns *hors-de-combat*.

Ships of 5,000 tons armed in this manner, whose probable length would be 270 feet, would have the guns placed as follows:—On each broadside, seven guns; the after gun being 68 feet from the stern, the remainder 22 feet apart, so that the formost gun would be 200 feet from the stern and 70 from the bow. Of these guns the five after ones would be of the heavier nature. Bow-guns would be on

the deck above, working in an embrasure-port, one on each side about 30 feet from the stem; this port admitting of their firing direct ahead, and about 10 degrees abaft the beam, and being so placed as not to weaken the resisting power of the bow, to the enemy's fire from ahead.

The fourth consideration is the system of armour. The public usually entertain most erroneous ideas of what the armour of an ironclad really consists, and the truth is so difficult to obtain, that even the officers serving on board our ships find the greatest difficulty in making themselves acquainted with the exact position of the different thicknesses of armour. The fact of Her Majesty's ship "Hercules" carrying a few hundred square feet of 9-inch plating, is often construed into her being covered with armour of that thickness. It is not to be wondered at that under the belief that her battery is efficiently protected, we find so many advocates for the "Hercules" class, and such opposition to the system of unarmoured batteries. The article referred to in *Blackwood's Magazine*, March, 1871, speaking of the armouring of another class says, "The 'Audacious,' when broad-"side on, presents an area of 6,670 superficial feet, of these only "3,277, or less than half, are plated at all. There is a patch of "100 feet by 3, at the water-line, of 8-inch armour, which tapers "down to 4½ inches at the bow and stern, and the rest of the ship "has nowhere any thicker armour than 6 inches; the ends of the "main-deck battery having only 4 inch, and 5 inch armour, while "the ends of the upper-deck battery are unprotected against a raking "fire, and more than half the ship's side is in the same unprotected "state."

This shows how slightly protected an ironclad really is.

I maintain that by arming a battery you not only limit it in size, but you give the ship too much top-weight, and, after all, it is not possible to render it proof against any of the heavier descriptions of guns. I would, therefore, in our sea-going ships, give up the idea of protecting anything but the water-line (and perhaps in the larger ships a conning-tower), with armour.

A vessel of 5,000 tons would be able to carry 440 tons of armour, or a belt 10 feet wide,—4 feet above the water-line, and 6 feet below it,—of from 10 inches thickness at the immediate water-line, to 8 inches above and below, and backed with wood. Besides this, an arrangement of coal bunkers (only to be opened from above, except when the coal was actually required for use), which would be an additional support to the backing, sufficient to cushion and prevent the further penetration of a projectile which may have already pierced the plating. I endeavour to explain this in an accompanying diagram, plate I, fig. 4. The water-line armour I propose to reduce from its full thickness at 100 feet from the bow, to half its full thickness at the bow. This would admit of the bow being further protected by light armour as high as the upper deck, 15 feet from the stem on each side. The stern-armour I would raise 6 or 8 feet, and would reduce the thickness of that at the water-line under the counter by 12 inches.

Ships of 7,500 tons would carry an armour-belt on the same principle; but the iron plating at the water-line would consist of two

layers, which together would make a thickness of 14 inches at the immediate water-line, and 12 inches above and below, the whole belt being 10 feet wide and 700 tons in weight; in fact, constructed on the same principle as the 5,000-ton ships just described.

The fifth consideration is the cost.

This, though the last, is not by any means the least in many ways. It does not become a nation rolling in wealth to quibble over the sum to be expended on the protection of that wealth. But in this, as in all other outlays, the country looks to receive the value of its money. A certain sum is yearly voted to furnish England with an efficient Navy, and if this is not wisely expended, the country becomes dissatisfied. But, should it at any time be necessary, that sum, great as it is, would be doubled. What we want, then, is not to lavish, but to be prudent in our expenditure, and to use such foresight in building our ships as will ensure our always holding the proud position of "*Queen of the Seas.*"

The cost of our present sea-going ironclads is so vast, that of necessity it greatly limits their number. By a reduction in their size and in the complications of their build, we should soon find ourselves possessed of a considerably larger number of really efficient ships for the same sum now expended on a few monsters!

In the question of guns *versus* armour, as heavier artillery was constructed, so larger ships were built, in order that they might carry a greater weight and thickness of armour. Now that it has been universally decided that the guns have won in the competition, and that no sea-going ship can be made proof against the later artillery, it is time to think how the maximum of efficiency in other respects, as well as in the protection against guns, may be attained. Dispensing with part of the immense weight of armour, ships constructed after the plan suggested above, need not be built of such enormous dimensions, and would still be able to carry an equally heavy battery, being at the same time sufficiently powerful as rams to sink with ease any ship afloat. We should then have (for a very considerably reduced cost) ships equal in many respects, and superior in some, to those of the "Hercules" class, though with unprotected batteries.

At present, if one of our most expensive ships is promiscuously sent to the bottom by a ram (friendly or otherwise), or by one explosion of a well-directed torpedo, the country loses a large fraction of its naval strength, amounting perhaps to $\frac{1}{16}$. Reducing that expense would admit of an increase in the number, and consequently render the loss of one ship comparatively trifling.

I will conclude this part with a summary of the principles I advocate.

1st. In order to render the ship as unsinkable as possible by artillery (at the expense of her battery being unarmoured), she must have a thick layer of iron-plating at the water-line, and a well-devised arrangement of backing to support it, which will furnish complete protection to her engines and steering gear. In order to render her as unsinkable as possible by ram or torpedo, she must have a complete and perfect system of water-tight compartments.

2nd. That the ship be provided with engines capable of propelling

her 14 knots (though personally I prefer a single engine, further experiments with double engines may prove their superiority); and steering-gear and rudder of the greatest efficiency, both being placed well out of reach of the enemy's guns.

3rd. That the ship have a ram-bow resembling that of Her Majesty's ship "Hercules," and carry a battery of 17 heavy guns, 14 of which shall be broadside guns, the remainder for bow and stern defence.

4th. That a system of armour 10 feet wide surround the ship at the water-line, sufficient to protect her from the fire of heavy artillery; that the bow be lightly armoured as high as the upper deck, and the stern to a height of about 10 feet above water.

I would suggest two classes of line-of-battle ships of this type. The *first class* to consist of about ten vessels of 7,500 tons, with armoured conning-towers; these ships would be used as leaders of divisions, sub-divisions, or groups. The *second class* to consist of about twenty vessels of 5,000 tons, ordinary ships of the line. I have named 14 knots as the full speed, because I consider a reserve of 4 knots necessary for a fleet of heavy ironclad rams when manœuvring at 10 knots, and this is the highest speed that human power is capable of directing safely under such circumstances.

Before concluding this part of the subject, I must make a few remarks on the steam launches I should like the larger vessels to be supplied with, if the fleet is to be employed for blockading purposes. Each large ship should carry a boat, built of steel, 50 feet in length, of the greatest possible speed, fitted with torpedoes that work either on bow or beam, the place for working which, and the boat, being protected with mantlets of steel. These boats would be found invaluable for reconnoitring the enemy's coast, for destroying their torpedo defences, and for spying the movements of their fleet. At the same time, their own great speed would be a protection against surprise, and their torpedo-armament, if so arranged as to be worked at full speed when passing a vessel, would render them most formidable.

Part II.

On Single Cruizers, of great speed.

This second part of the Essay presents a wide and varied field for the consideration of our ship-builders. The individual construction of cruizers is not so important a question as that of the individual construction of ships-of-the-line; but the vast number necessary for the protection of our colonies, and of our enormous maritime commerce, gives these ships, as a portion of our naval power, a value equivalent to that of the ironclad fleet.

Our present fleet of cruizers is equal, both in number and quality, to the duties required of it. Many of the older ships are doubtless of insufficient speed, and, in case of war, could not be employed where they would meet with the enemy's swifter vessels. But of late years there has been a revolution in the build of cruizers. Iron has to a great extent been substituted for wood; and, in order to admit of

greater speed under steam, the lines of a ship are finer, her length greater, and her beam less, in proportion to her size. Greater speed has thus been obtained, though doubtless at the expense of some of the other good qualities. For instance, ships of great length are unhandy under sail, and owing to their small beam, are often crank.

In order to take a rapid glance through our present strength in cruizers, we will divide them according to the periods to which they belong, and those divisions we will sub-divide, classing ships of the same tonnage of displacement together in regular order, commencing with the larger ships.

1st Division.

"Inconstant" class	..	3 ships ..	(about) 5,700 tons.
"Boadicea" „	..	1 ship ..	„ 4,027 „
"Bacchante" „	..	2 ships ..	„ 3,932 „
"Rover" „	..	1 ship ..	„ 3,494 „
"Active" „	..	2 ships ..	„ 3,078 „
"Amethyst" „	..	1 ship ..	„ 2,144 „
"Encounter" „	..	2 ships ..	„ 1,934 „
"Diamond" „	..	2 „ ..	„ 1,890 „
"Briton" „	..	3 „ ..	„ 1,875 „
"Emerald" „	..	6 „ ..	„ 1,864 „
"Cormorant" „	..	5 „ ..	„ 1,124 „
"Albatross" „	..	6 „ ..	„ 894 „
"Arab" „	..	2 „ ..	„ 620 „
"Frolic" „	..	4 „ ..	„ 592 „
"Ariel" „	..	12 gun-boats	„ 463 „
"Mallard" „	..	3 „ ..	„ 420 „

This division includes, three frigates, twenty corvettes, seventeen sloops, and gun-vessels, and fifteen gun-boats. All these types of vessels are of the latest models, swift steamers for their respective sizes, and most of them of composite build; and the greater number are as efficient cruizers as any yet constructed. Two of the three frigates, the "Inconstant," and the "Raleigh," have been thoroughly tried, and found to possess immense speed under steam, and good sailing power (though they are crank, and somewhat unhandy). Both ships carry a powerful battery of guns, and would be invaluable in war-time, as the flag-ships of detached squadrons, whose duties would be to act as the eyes of the principal ironclad fleet. The third frigate, the "Shah," we know to be of equal power with the other two, though she has not yet been tried. The next three on our list, the "Boadicea," "Bacchante," and "Euryalus," are not yet launched; these, with the "Rover," will, I believe, prove themselves to be the first cruizers in the world, especially the "Bacchante," "Euryalus," and "Rover," which, in addition to their other exceptional advantages, have bows strengthened for ramming. The "Active" and "Volage" are powerful steamers, and considerably above the average. The ships of the "Amethyst," "Encounter," and "Briton" types, though

efficient, have been improved upon, and are somewhat superseded by those of the "Diamond" and "Emerald" types. The "Cormorant," and her sister-ships, are still to be tried; and the remaining five types, of vessels and gun-boats, in this first division, are fully equal to their duties.

2nd Division.

Frigates.

"Ariadne"	class ..	..	..	2 ships	8
"Bristol"	„ ..	..	..	5 „	
"Endymion"	„ ..	..	..	1 ship	

Corvettes.

"Barrosa"	„ ..	..	..	4 ships	13
"Juno"	„ ..	..	..	2 „	
"Blanche"	„ ..	..	..	7 „	

Sloops and Gun-vessels.

"Daphne"	„ ..	..	..	4 „	53
"Cameleon"	„ ..	..	..	5 „	
"Fawn"	„ ..	..	..	1 ship	
"Petrel"	„ ..	..	..	4 ships	
"Myrmidon"	„ ..	..	..	4 „	
"Bittern"	„ ..	..	..	12 „	
"Avon"	„ ..	..	..	18 „	
"Dart"	„ ..	..	..	5 „	

Gun-boats.

"Britomart"	„ ..	..	..	11 „

In this second division are the last ships built before the composite construction was introduced. The eight frigates, the "Barrosa," "Cameleon," "Fawn," and "Petrel" classes, are without exception magnificent cruizers—perfect in symmetry of form, swift as possible under sail, and carry an efficient armament. Unfortunately, they lack both steam-power, and space for fuel; thus, beautiful as these ships are, they belong to the past, and it is sad to think that we shall never see their like again.

The "Juno," and her sister-ship, were built with troop-decks, but are not considered a success. The "Blanche" and "Daphne" types failed considerably in speed, and their sailing-power was reduced to a minimum, by their not being able to lift their screw-propeller. The smaller types of this division, though still useful, have been improved upon, and need no particular mention.

3rd Division.

Frigates.

"Aurora"	class ..	..	..	8 ships ..	8

	Corvettes.			
"Challenger" class	.. .. ..	3 ships	}	9
"Cadmus" „	.. .. ..	6 „	}	
	Sloops.			
"Gannett" „	.. .. ..	1 ship	}	2
"Lyra" „	.. .. ..	1 „	}	
	Paddle-frigates.			
"Terrible" „	.. .. ..	1 ship	}	3
"Valorous" „	.. .. ..	2 ships	}	
	Paddle-sloops.			
"Basilisk" „	.. .. ..	8 ships	..	8

This division contains the oldest cruizers in our Navy. The frigates and corvettes are still used, and many of them are fairly efficient; but all the ships are above eighteen years of age, and belong so entirely to the past that we need not take them into consideration.

It is apparent, from the above lists, that the first division alone contains anything approaching the types that can be advocated for the future cruizer. Doubtless there are some most admirable types in its numbers; but I find two principles omitted in the construction of them, one partially, the other entirely. The principle partially omitted is, the great importance of the power of the *ram*. Why should not all men-of-war, whether cruizers or ironclads, be capable of sinking an enemy by ramming her? It is true that some of the last built cruizers have bows strengthened for ramming, but there is no sharp point, or spur, in the form of their bow, and the shock of an up-and-down bow striking the upright side of an ironclad would be terrible to the rammer, even if fatal to the ship rammed. Whereas a point would enter, and cushion the blow on the bow, at the same time sinking the enemy. In fact, an up-and-down bow strengthened for ramming is the only substitute possible (in vessels built for immense speed), for a more formidable ram, to support which, the extreme fineness of the ship's lines would, to a certain extent, have to be sacrificed. I would suggest a bow of much the same shape as that of Her Majesty's ship "Hercules," though not so projecting, but certainly coming to a point at about six or eight feet below water. The principle referred to as "wholly omitted" is "*any system of pro-*
"*tection to prevent the ship being sunk, or her machinery damaged or*
"*destroyed by artillery.*" My opinion is, that by a slight reduction in the length of the ship, and a slight increase of her beam, sufficient floating power would be obtained to enable a 5,000-ton ship to carry a light belt of armour at the water-line, which would materially strengthen her bow for ramming. This belt would be of the following dimensions:—8 feet wide (*i.e.*, $4\frac{1}{2}$ feet below, and $3\frac{1}{2}$ feet above, water), 5 inches thick from before the boilers to the stern, and 4 inches forward. The increase of beam would allow space for larger, and consequently more powerful engines, and would give more room on the gun-deck.

The belt of armour plating at the water-line should be supported by a system of coal-bunkers, similar to those I advocate for ships-of-the line. This armour may be calculated to resist *all* fire from light guns, and oblique fire from heavy artillery. The chain cables, hung round the United States steamer "Kearsage" during her engagement with the "Alabama," are an illustration of how efficient even the slightest protection of this sort is. The vital parts of the ship are well protected, and she is rendered comparatively unsinkable. My ideas, then, for the future types of cruizers are as follow:—

Full-rigged ships, constructed with ram bows, and lightly armoured at the water-line, in the manner I have described. Ships of 1,000 tons and upward, I divide into five classes, and give their approximate dimensions, in the following table:—

Classes.	Tonnage of Displacement.	Approximate Dimensions.			Armour-belt at water-line.				
					Thickness.		Width.	Approximate weight.	
		Length.	Beam.	Draught	Aft and amid-ships.	Forward		Armour.	Fastenings and backing.
							Ft.	Tons.	
Frigates, 1st class.	5,000	300	53	24	5″	4″	8	202[1]	An additional weight of 1 to every 3 tons of armour.
Spar-decked Corvettes, 2nd class.	3,800	270	46	21	4½″	3½″	7	143	
Corvettes, 3rd class.	2,500	235	40	19	4″	3″	6	96	
4th class.	1,800	200	37	17	3½″	2½″	6	66	
Sloops, 5th class.	1,000	180	34	16	3″	2″	5½	47	

The first and second classes would carry 21 guns, of 4½ and 3½ tons respectively; the third, fourth, and fifth classes would carry 17 guns, of from 3 to 1½ tons weight. The frigates and spar-decked corvettes must possess a speed of not less than 15 knots; the third and fourth classes, 14½ knots; and the fifth class, 13½ knots.

The rudder and steering-gear for these ships should be worked as much as possible under the protection of the armour.

Water-tight compartments of the same description as those recommended for the ironclads, will be necessary. In fact, there will be a great similitude in the internal arrangements of all ships, whether ironclads or cruizers.

Gunboats, of less than 1,000 tons, are too small either to carry heavy armour or to have any considerable speed, but all should be capable of attaining from 11 to 12 knots. Vessels of the latest build, such as the "Albatross," "Frolic," and "Mallard" classes, are all that can be required for this type.

[1] It appears that this amount should be doubled (*vide* discussion on the Essay). —Ed.

It will be observed, that the speed of this description of armour-belted cruizer does not, in some cases, equal that of our present vessels. For instance, Her Majesty's ship "Inconstant," on her trial, made good over 16 knots, which exceeds by $1\frac{1}{2}$ knots the speed I have laid down for my quickest "*belted cruizers.*" But, taking into consideration their slightly enlarged mid-ship section, and their fuller bow, supporting the ram, we cannot expect for them, nor do we require, the enormous speed of the "Inconstant." It may happen that some enterprising nation, determined, in case of war, to cut up our commerce, should for this purpose build some extremely fast cruizers. To frustrate any attempt of this sort, I would add another class of vessels to the above list, and give them the name of "*special cruizers.*"

These ships should be corvettes of 3,500 tons displacement, with up and down bows, strengthened for ramming, and every other consideration made subordinate to speed; no armour, and not overweighted with a heavy battery. The "Rover" is a good type of this class.

Mr. Thomas Brassey, M.P., in his very able and reliable pamphlet on "unarmoured ships," explains and comments on several points of interest. Among these, he wisely condemns the excessive expenditure on individual ships, and, whilst declaring it will be necessary to build ships for special purposes, brings into prominent notice that "for the tremendous exigencies of war, the fleet might be supplemented and expanded so as to acquire undisputed ascendancy, by equipping and arming our ocean mail-steamers."

His opinion on this subject I believe to be sound, though personally I am inclined to attach more value than Mr. Brassey does to the importance of actual men-of-war cruizers.

The cost of cruizers has been well argued out in this pamphlet; and, on referring to it, it will be seen that Mr. Brassey strongly urges, "building ships of the smallest dimensions consistent with the attainment of the requisite speed." I agree with him in this to a certain extent, and would therefore limit the number of ships above 2,500 tons, and increase that of those below it. The number and duties of the cruizers I propose should be somewhat as follows:—

6 "*Belted cruizers*" *of the 1st class* (5,000 tons); of these three would be flagships on the China, Pacific, and East India Stations; the remaining three for special service as flag-ships of detached squadrons.

12 "*Belted cruizers*" *of the 2nd class* (3,800 tons), half of which would be employed as Commodores' ships, and as supplements to squadrons abroad; the other six reserved for special service in detached squadrons.

6 "*Special un-armoured cruizers*" of great speed, which would be sent where most required if war were imminent.

The actual number of the smaller classes would not be limited, but the proportion would be about twelve of the 3rd class (2,500 tons); twenty-four of the 4th class (1,800 tons)—N.B. This is the most useful class for service on foreign stations;—eighteen of the 5th class

(1,000 tons); and smaller sloops, despatch vessels, and gun-boats, to the number we possess at present. Ten or twelve, extremely fast, small steamers protected by bullet-proof steel mantlets, and fitted to tow a Harvey torpedo (from their foremast) on each side, would greatly augment the strength of an ironclad fleet in a general action; I would, therefore, recommend their being added to our list of smaller vessels.

With some remarks on two or three questions of minor importance, I will finish this part of the essay.

The first, is the ability to hoist the screw—this I consider indispensable for all cruizers. As they are required to traverse the ocean, and go in and out of harbour under sail, it is most important to have thorough command of the ship under canvas, which cannot be attained with the screw in its position for propelling.

The second is the casing for the screw referred to in Part I. I do not think it will be of service for cruizers, as it must materially diminish the power of the rudder when the screw is not working. This would have the same evil effect as a non-protected fixed screw. But, perhaps, when this new apparatus has been more thoroughly tested, an improvement may be added, by which the ship can be steered under sail with a covered screw in position.

Part III.

Of Ships required for Coast Defence.

I do not know whether it is prejudice on my part or not, but I have never been able to place faith in the "Devastation" class. From the time of the laying of the so-called keel of this ship, I have had an utter distrust of her—there seemed too much likeness to those unfortunate American monitors, so many of which were lost in moving from one port to another during the war. At first, I did not think she would stand the trials necessary to prove her sea-worthiness, but no one reading the satisfactory results of those trials can have a doubt of it. Besides this, I have the testimony of one of our ablest naval men, that she is the most buoyant vessel in a sea-way he had ever been on board of. But a question of more vital importance is, what would her behaviour be in an action, or after it, should she be injured, if a long way from port and experiencing rough weather? I consider this ship so admirably balanced that she is perfectly safe so long as she is intact. But I should like to see her tried, with all her light ironwork (which in action would be pierced by the smallest projectile), open to the wash of the sea. In the first place, the mere fact of steaming at a high speed, under these circumstances, would fill the men's compartment, the armoured deck on which this stands being only one foot above the water-line. This would be done by the bow-wave, which at her full speed reaches the top of the compartment mentioned. Thus an enormous body of water would be lodged on the upper part of the ship forward, reducing her speed considerably and rendering her unsafe as a floating body in a sea-way, in fact, in all probability,

destroying her balance. Confident as I am in her safety in peace-time, I cannot but condemn her as an instrument of war.

The "Inflexible," now building at Portsmouth, is supposed to be an improvement on the "Devastation." She is to carry 20- and 24-inch armour, and an armament of four 81-ton guns. From this casual description, one is led to believe that the "Inflexible" is a most formidable monster. But when we come to enquire into particulars, we are astonished at her want of efficiency as a fighting ship. The armour, impenetrable as it no doubt is, only protects a part, amounting to about one-third of the ship's upper works. This protected part is in the form of a citadel 110 feet long, by 75 feet wide (or the whole beam of the ship), and the armour-plating is in two layers of 10-inch thickness, 16 feet wide (the outer plates at the immediate water-line being 14 inches thick instead of 10 inches). On the top of this breastwork, which rises to a height of 10 feet above the water-line, are the two turrets, so placed at opposite corners of the citadel, that the fire of all four guns can be delivered direct ahead, astern, and on either beam. This battery of four 81-ton guns will be, both in form and dimensions, the most powerful afloat. And yet the safety of this formidable structure depends on a balance, more delicate and more easily disarranged than that of Her Majesty's ship "Devastation," for, the remainder of the ship's side, a length of 200 feet, is totally devoid of outside armour, and the only protection is in the 3-inch armoured deck, 6 feet below the water-line, connected with the lower ends of the athwart-ship breastworks. Thus we see that nearly two-thirds of the upper-works down to 6 feet below the water-line are as easily damaged as the light ironwork of the "Devastation," and in action would be knocked away by the smallest artillery; and so, to the floating power of the comparatively small space below the 3-inch armoured deck, is left the mighty task of keeping this so heavily weighted ship from sinking, and this only on the condition that the armoured deck remained water-tight. The ship's great beam would, however, certainly be of great assistance in preventing her capsizing. There is one point of great value to be observed in the construction of the "Inflexible," viz., the admirable plan of bringing the rudder-head into the ship below the water-line, and working the steering-gear below and under the protection of the armoured deck.

The "Rupert," "Glatton," "Hotspur," and "Cyclops" classes are, in my opinion, even less valuable as types of fighting ships. It is true that they are not intended for sea-going purposes, but to my mind, all ships-of-war, whether for ocean-warfare, or for coast-defence, must be constructed with a reserve of floating power, which would enable them to be seaworthy when seriously injured. This is certainly not the case with these ships.

Our vessels for coast defence at present number in their ranks:—

1st. The "Inflexible" (11,165 tons);
2nd. The "Dreadnought" (10,950 tons); "Devastation" and "Thunderer" (both 9,190 tons);
3rd. The "Rupert" (5,444 tons) "Glatton" (4,912 tons); "Hotspur" (4,010);

4th. The "Cyclops," "Hecate," "Hydra," and "Gorgon," (3,430 tons);

5th. "Royal Sovereign" (5,080 tons); and "Prince Albert" (3,905 tons);

the first turret ships constructed. From what I have said before, it may be perceived that I do not agree with the principles on which these ships are built.

There is a type of vessel, so novel in its construction, so opposed in its form to all that has gone before, that our naval architects have not, as yet, undertaken the responsibility of giving it a trial. I refer to the circular ironclads, the type of which was first designed by the late Mr. John Elder, and on the subject of which he lectured at the Royal United Service Institution in May, 1868.

The Russian shipbuilders, more adventuresome than ourselves, have taken the lead and have already constructed two circular ironclads, the "Novgorod," which is completed and has been tried, and the "Popoffka," now nearly completed, which is building at Nicholaeff, entirely from Russian resources, under the direction of Admiral Popoff. These vessels are poor specimens of a type, which I believe will prove, when developed and more thoroughly tried, the most perfect for coast defence.

The "Novgorod" is a circular monitor of 2,490 tons displacement, and of 480 horse-power. Her diameter is 101 English feet, and she draws 13 feet 2 inches with all stores on board. Her armoured breastwork is (with the backing) 11 inches of iron. The deck, outside the breastwork, is plated with $2\frac{3}{4}$ inches of iron. She carries two 28-ton steel guns, working inside the breastwork. She is propelled by six screws, and on her trial she attained a speed of between 7 and 8 knots. Her cost was about £330,000. To my mind, vessels of this class would be of more value if of greater size, and the cost of the larger vessels would be in proportion considerably less.

I would invite attention to the late Mr. John Elder's able paper on this subject, published in the Journal of the Royal United Service Institution, No. 52, though in many points I do not quite agree with it. I think Mr. Elder overrates the power of this type when he says, "that there is no reason why a vessel of the same displacement as one "of our best ironclads, but circular in form, may not be propelled at "an equally high rate of speed," &c. My opinion is, that a speed of from 8 to 10 knots is quite sufficient for coast defence vessels such as these, whose motive power is only required in moving them from one part of the coast to another, where they would act as floating and movable forts, for its protection against an invading force.

I should be inclined to adopt a system of propulsion, by means of three, or six screws after the Russian plan, in preference to the arrangement of hydraulic propelling apparatus, which Mr. Elder recommends, until we know more of water-power as a propeller for ships.

On the question of ramming also, I do not hold Mr. Elder's opinion. For, in my belief, a circular vessel is not competent, neither is she required to be used as a ram. In fact, this type of vessel is

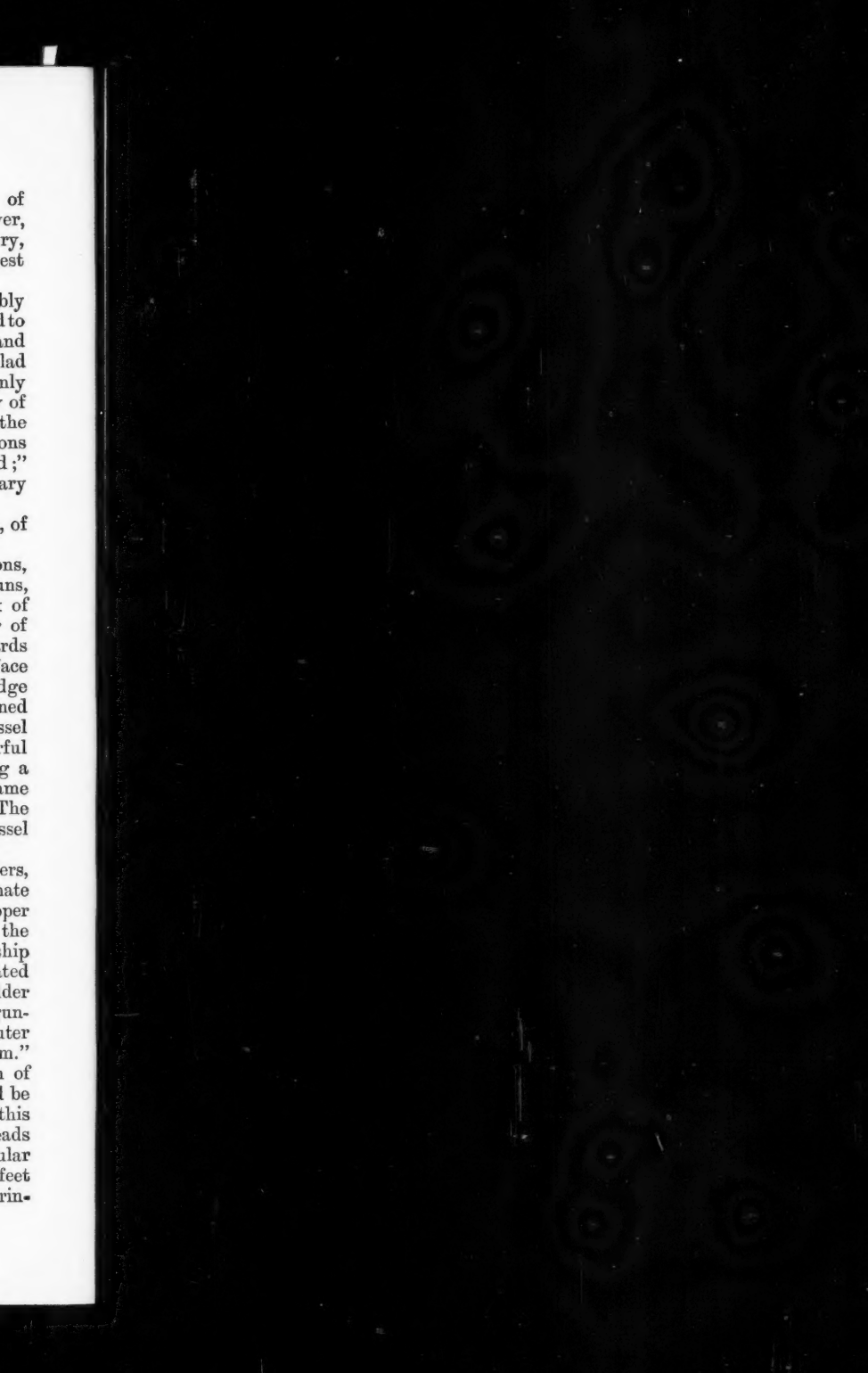
exactly what we want, without either great speed or the power of ramming. Her invaluable qualities are, undoubted floating power, comparatively small draught of water, impenetrability by artillery, power to resist the attack of rams, and ability to carry the heaviest possible ordnance.

I see in this form of vessel the only floating body that can possibly combine these all-important qualities. Great value may be attached to the arguments that the reading of Mr. Elder's paper gave rise to, and it will be observed that the admirable qualities of this circular ironclad were recognized by all the scientific men present; and that the only two questions not agreed upon were—first, as to the possibility of steering her on a straight course; and secondly, of her attaining the extreme speed hoped for by the author. The first of these questions has been satisfactorily solved by the trials of the Russian "Novgorod;" and the second, by the fact that such extreme speed is not necessary for coast defence.

Mastless circular vessels for coast defence would be, I propose, of two classes:

The type of the first class would be a vessel of about 8,500 tons, 210 feet in diameter, carrying batteries of twelve 12-inch 35-ton guns, mounted on an improved Moncreiff system, behind a breastwork of 14-inch armour, 6 feet high, and circular in form, with a diameter of 100 feet. The deck outside this breastwork to curve downward towards its outer edge, and to be plated with $3\frac{1}{2}$-inch iron. The under surface nearest the edge would also be plated with $3\frac{1}{2}$-inch armour. The edge itself would be protected by a steel rim of immense strength, sharpened so as to cut the bow of a vessel ramming her. This circular vessel would be propelled by three screws, and engines sufficiently powerful to give her a speed of 10 knots. In order to ensure her having a good grip of the water, I propose constructing four keels, in the same direction as, and between which, the screw shafts will work. The lower surface of these keels will form a flat bottom, so that the vessel can be, without danger, landed on a gridiron. (Plate III, fig. 1.)

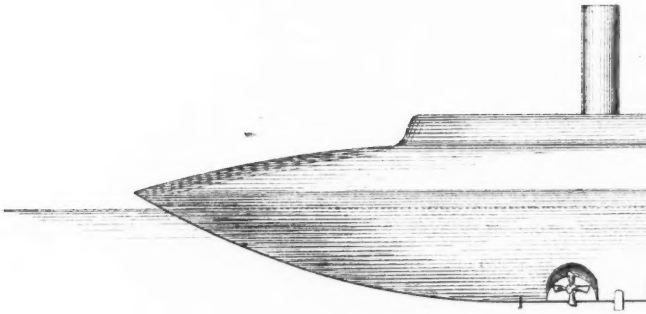
In the after ends of the centre keels would be two powerful rudders, which would give the ship efficient turning power. Approximate weight of armour of this first class: breastwork,—500 tons; upper surface of armoured deck, 1,700 tons; under surface, 450 tons; the total weight being about the same as that of Her Majesty's ship "Devastation." The construction of this vessel is less complicated than that of ordinary iron ships, the difference being (as Mr. Elder says) "that the frames and floors, instead of extending from keel to gun-
"wale athwart ships, radiate from the centre to gunwale at the outer
"edge; every frame and floor being the same length and form." Nothing is simpler than the division of the interior of this form of ship into water-tight compartments. When afloat, her edge would be three feet above water, the principal horizontal deck being on this level, and all the space below divided into small cells by bulkheads radiating from the centre, intersected by others, following the circular form of the ship. All the bulkheads, from the outside edge to 35 feet towards the centre, would be continued upwards beyond this prin-



CIRCULAR IRON

Diameter 30 feet Tonnage

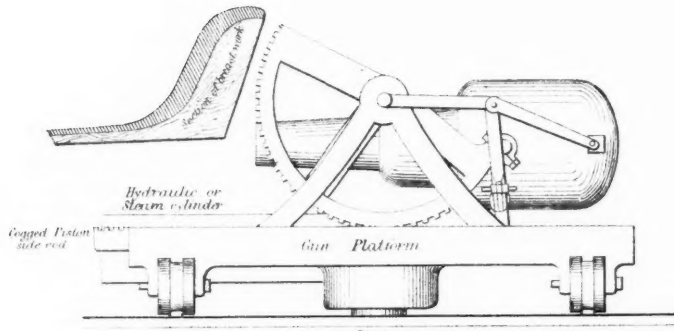
F



Scale, 3

Fig 3

Shewing gun in position for loading.



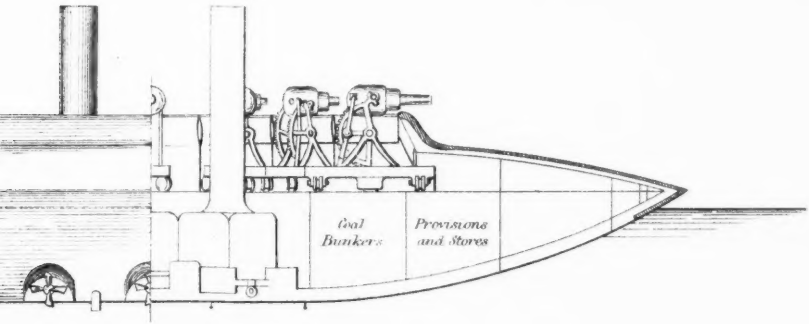
Scale 8 ft

Plate 2

AR IRON-CLAD 1ST CLASS

0 feet Tonnage of displacement about 8.500

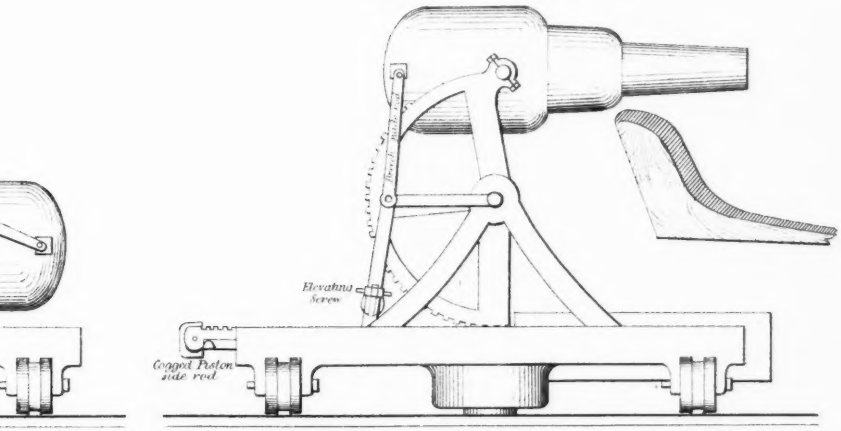
Fig 1



Scale, 55's feet to an Inch.

Fig 3.

Showing gun in position for firing

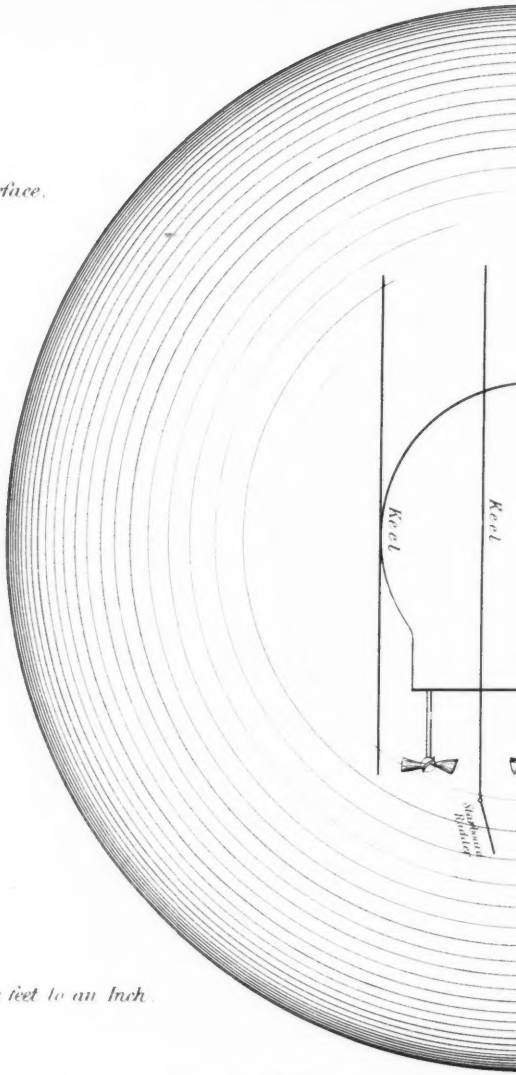


Scale 8 feet to an Inch.

CIRCULAR

Fig 1.

Lower Surface.



Scale - 33⅓ feet to an Inch

CULAR IRONCLAD.

Plate 3

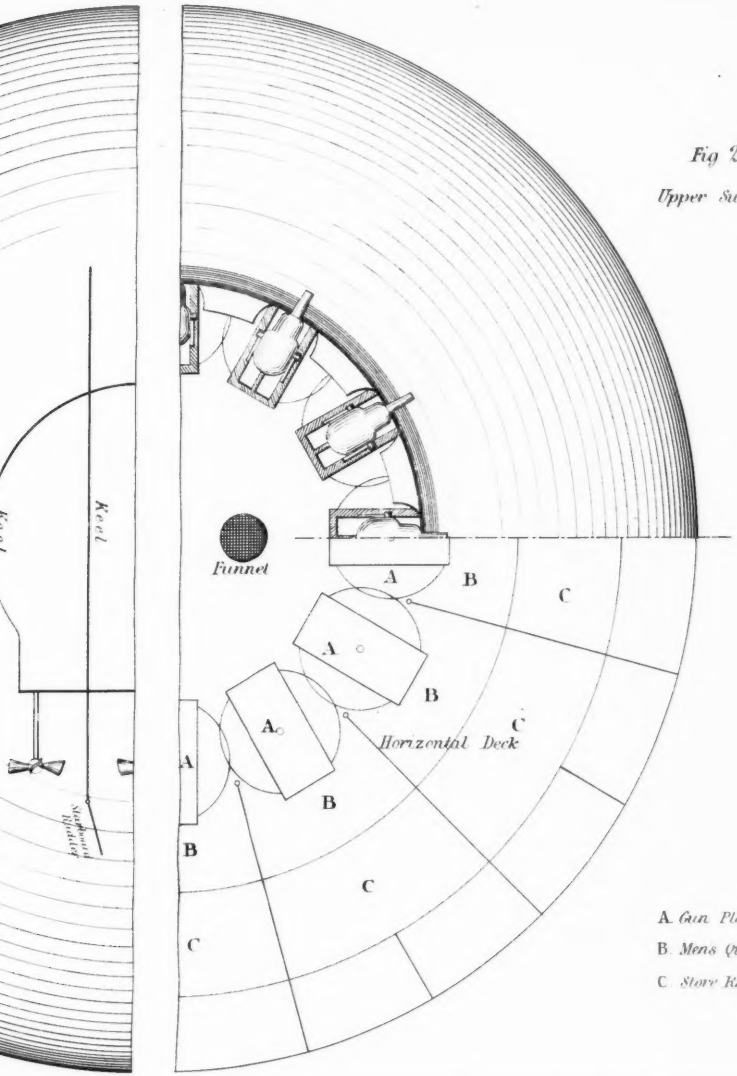


Fig 2.

Upper Surface.

cipal horizontal deck, and join the curved armoured deck above. (Plate II, fig. 1, and Plate III, fig. 1.)

The twelve guns will be arranged at equal intervals on the horizontal deck, within the circular breastwork, and their carriages would be made to revolve on a pivot in their centre (which will be about six feet from the breastwork towards the centre of the ship), so as to enable the guns to range over an arc of 120°. The guns, when in position for firing, would be seen from outside "en barbette" (Plate II, fig. 3), the recoil would bring them into position for loading (Plate II, fig. 2), from under the armoured deck. The degree of training provided for, would admit of five of these monster guns being pointed in the same direction. When fired from the position of their extreme training, it would probably be found that the concussion of the explosion would be very much felt in-board. In order to rectify this, I would suggest, that horizontal platforms be arranged between the guns, on a level with the top of the breastwork, and extending about five feet in-board. In the centre of the ship there must be a conning-tower, provided with a rifle-proof cover, from under which the captain can look over the breastwork, and direct his ship in action.

The type of the second class would be a vessel of about 5,000 tons displacement, 150 feet in diameter, carrying a battery of twelve 10-inch 18-ton guns, mounted behind a circular breastwork of 12-inch armour, 5 feet high, the diameter of which circle would be 80 feet; the plating of the outside deck 3 inches thick. The approximate weight of armour for this vessel would be:—breastwork, 270 tons; upper surface of armoured deck, 700 tons; under surface of edge, 230 tons; total weight about 1,200 tons. The whole vessel is constructed on the same principle as that of the first class. In all probability, there will be at first great opposition to this innovation; but I am positive that, once tried, this type will be universally adopted for coast defence.

In addition to these floating forts, we require, for the protection of our coasts, small torpedo vessels and gunboats.

The Americans have recently launched a torpedo vessel, by name the "Alarm," which was described in *The Army and Navy Journal* a short time ago. She is 100 feet long, 28 feet beam, 10 feet draught, has a ram-bow, and carries one heavy gun and eight Gatlings, in addition to her torpedo-gear, which is reported to be very perfect. This class of vessel is of undoubted value as a coast-defence, which we should probably realize to our cost, in the event of war with the United States. But the handling of such dangerous instruments as torpedoes on board ship, is so apt to prove as fatal to the workers of them as to the enemy, that they would be a questionable advantage to this nation, whose coasts are so admirably defended in other ways.

Gunboats of the "Comet" class, carrying one gun of great weight, will be found an exceedingly useful addition to the defences of the coast, and the fact of our possessing twenty-four of them already, is very satisfactory.

In order to have an efficient coast-defence fleet, we ought, in my

opinion, to possess four circular ironclads of the first class (about 8,500 tons), for the Thames and south coast ports; six circular ironclads of the second class (about 5,000 tons), to be stationed at other ports in the United Kingdom; and thirty gunboats of the "Comet" class divided along the coast, where most required. To these, torpedo vessels may be added, when a really valuable type has been introduced.

Monday, March 27th, 1876.

ADMIRAL SIR HENRY J. CODRINGTON, K.C.B., in the Chair.

DISCUSSION ON THE NAVAL PRIZE ESSAY, ON "THE BEST TYPES OF WAR VESSELS FOR THE BRITISH NAVY."

Admiral Sir SPENCER ROBINSON: Sir Henry Codrington, when I was invited to come here and discuss this subject I naturally felt some little doubt as to the nature of the discussion, because I did not quite understand whether the prize had already been awarded or whether we were called upon to discuss the merits of the essay itself as deserving the prize. We now understand that the medal has been awarded to the author of this Essay, and, therefore, that the discussion that we have to enter upon, is a discussion as to whether this Institution can recommend the new type of ship which Captain Noel has so cleverly and so ingeniously advocated, and which has received the approbation of the referees. In discussing this subject I must ask the Chairman and everybody here to allow me, what I am not only most willing, but most anxious always to concede to everyone with whom I may be brought into discussion, I mean perfect liberty of speech, that I may be allowed to say what I think upon each topic as it arises, and that no one—neither the talented author, nor his friends, nor the referees who have awarded him this medal—will consider that in anything I say, I have the smallest desire personally to be offensive or disagreeable to them; but that I simply stand forward to advocate such principles as I believe to be right and perfectly legitimate principles to hold; and as to any part I may take in this discussion, and any language I may use, I beg leave at once beforehand if anything looks personal, or might be construed into giving offence, to apologise for using such language. All I wish, is to have a discussion on a subject of vital importance to the British Navy, perfectly unfettered in the line of argument that any gentleman or myself may think fit to adopt.

Having cleared the way, I should like just to say one or two things before I really go into the subject of the merits or demerits of the Prize-essay. I think it would be extremely unfair, and I should feel that I was doing wrong if I put the weight of my years or authority in any way to override the opinions of a young commander who has written upon subjects of the greatest possible importance. I think that every one in our profession, and probably every one of those who are out of it, will consider that the trouble, the time, the ingenuity and talent that that gentleman has displayed in writing the Essay, is worthy of all commendation; and that, even when we most differ from him, we ought to treat the opinions he has been kind enough to lay before us, with every possible consideration, tenderness, and regard. I find it necessary, as I am sure the author of this Essay found it necessary, to clear the road before considering that type of ship which he considers best adapted for our ironclad navy, and to do so by observing that all the types of the ironclad navy now in existence are seriatim and unreservedly condemned by the author of that essay. Nay, more, it appears to me that if he had not completely and unreservedly condemned those types he would not have had a *locus standi* for introducing to our consideration a type of warship—a type of ironclad as he calls it—so entirely different from anything that has gone before it. He pre-supposes,—and I follow him in his pre-supposition,—that the whole of these types being extremely defective[1] it is

[1] Page 1. "We find ourselves unable to arrive at a conclusion as to which is the "most satisfactory type."

Page 2. "But grand as our fleet is collectively, it is not satisfactory to observe

absolutely necessary without delay to produce a novel type, and that this type with all the disadvantages that may attend upon it, is better and more fit for the purpose of an ironclad navy than the types that have gone before it. It is necessary, therefore, to examine why he finds fault with the types of ironclads that have gone before, to see whether his reasons are such as the facts of the case will bear out.

I should like to begin with what he said about the "Iron Duke" class. He said of the "Iron Duke's" class that they were generally considered as failures; and he has described the class by a quotation from *Blackwood's Magazine*.[1] In that quotation there are two rather important errors. He has, however, declared the "Iron Duke's" class to be a failure. Now I should like to ask every gentleman in the room what he means by the word "failure." If you design a tool to perform certain work and it performs that work, is it a failure? If you aim at a given object, and you hit that object, is that a failure? If the "Iron Duke" was designed to do certain work, and she does that work, is she a failure? Is a ship a failure because you having aimed at one object, have realised that object, but have not aimed at another object, and have not realised that other object? I should say certainly not. What is an ironclad, I may ask, designed for? An ironclad is designed to fight such battles on the seas as we may be compelled to fight with weapons equal or superior to those that are brought against us. I should like to compare for a moment an ironclad of the second class, such as the "Defence," with the "Audacious;" comparing the latter first of all with the ironclads designed in earlier days by naval constructors in England, and secondly with the second class ironclad of any foreign power with which she might be called on to cope. Allow me first of all to take you to the "Defence," which was the first of the second class ironclads designed in England, and show you the difference between the "Defence" and the "Iron Duke." The length of the "Defence" is 280 feet, breadth 54 feet, mean draught of water 25 feet 1 inch, height of ports out of water 6 feet 6 inches. She was 6,070 tons displacement, carried 607 tons of 4½-inch armour, mounted two 8-inch and eight 7-inch guns. Her speed was 11·6 knots, and her powers of action limited by 460 tons of coal. The "Iron Duke," designed as a second-class ironclad, was 280 feet long, 45 feet wide, her mean draught of water 22 feet, height of ports 8 feet 1 inch, displacement 6,034; she

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"that of all the types represented therein few can truly be called the recognised "types of the future, and these few are of minor importance."

Page 3. "Besides this (the enormous cost) the 'Sultan' has the defect of excessive "top weight, to counterbalance which, 600 tons of ballast have already been put into "her, and, indeed, in all these vessels the fact of protecting their batteries with "heavy armour is, in my opinion, a questionable principle, for by so doing, the size "of the battery is curtailed, and the ship is rendered crank. The 'Monarch' "would be subject to the same objections as the 'Hercules.' The second class "includes the 'Audacious' and her five sister ships. These, though powerful "vessels, are generally considered failures. Insufficiently plated at the water-line, "overburdened with heavily armoured box-batteries above the upper decks, their "first trial proved them so excessively crank as to be wholly unseaworthy."

Page 18. "Confident as I am of her safety [the 'Devastation'] in peace-time, I "cannot but condemn her as an instrument of war."

Page 18. "But when we come to inquire into particulars, we are astonished at *her* "want of efficiency as a fighting ship" [the "Inflexible."]

Page 19. "From what I have said before, it may be perceived that I do not agree "with the principles on which these ships are built—viz., all the turret-armed ships "in the navy."

[1] "The 'Audacious,' when broadside on, presents an area of 6,670 superficial "feet; of these only 3,277, or less than half, are plated at all. There is a patch "of 100 feet by 3 at the water-line, of 8 inches armour, which tapers down "to 4½ inches at the bow and stern, and the rest of the ship has nowhere any "thicker armour than 6 inches, the ends of the main-deck battery having only 4 "or 5 inches armour, while the ends of the upper-deck battery are unprotected "against a raking fire; and more than half the ship's side is in the same unpro-"tected state."

carried 924 tons of 8-inch, 6-inch, and 4½-inch armour, ten 9-inch guns; her speed was 13½, and she carried 540 tons of coal. And now that I am on the subject of the armour plating of the "Iron Duke," I may as well refer to that description in *Blackwood* which says that the ship had only got a very limited portion of 8-inch armour, and the rest was entirely built up of smaller armour, and that there was, with the exception of its belt on the water line of 8 inches, nowhere any other thicker armour than 6 inches, and also to the statement that the armour-plated upper-deck battery was undefended against raking fire. All these facts are liable to very great correction, which I proceed to give. Not only is there an 8-inch armour-plate streak above the water-line of the "Iron Duke," class,[1] but in the wake of the ports, that is, in the important place where the pivoting of the guns is secured, on which the whole efficiency of the battery depends, there is a strip of 8-inch armour. The armour at the corners of the upper deck battery is 5½-inch thick; and there are two thwart-ship bulkheads protecting it against raking fire, reduced to 4½ inches in thickness only where no man would be stationed in action; and any direct shot coming upon one of those bulkheads must have passed through the ship's side or extremities before it could get there. If it came in a straight line it would walk out interfering probably with nobody. Of course it might be perverse and do other mischief, which I cannot describe at this moment, but at any rate, the badly defended state of the "Iron Duke's" class, about which the author of this pamphlet seems to have been seriously concerned, and which tempted the writer in *Blackwood* to say how little the iron-clad ships were defended, does not seem to me to stand on very serious ground. Having shown you the difference between the second-class armour-plated ship, the type of which is so unreservedly condemned, and the former second-class ironclad, allow me to proceed to show you the comparison between this second-class ironclad and the French ships. The French, at the time this ship was built, had two classes of ships afloat —the one represented by the "Flandre," of which type there were ten—the "Surveillante, "Valeureuse," and a number whose names I do not recollect at this moment. They were first-class French ships; and bearing in mind what I have told you about the dimensions and thickness of the armour plating and the armament of the second-class English ship, allow me to read you the dimensions, thickness of armour plating, &c., of the French first-class armoured ship. The French first-class armoured ship of that day, as represented by the "Flandre," was 262 feet long, 55 feet 9 inches beam, draught of water, 25 feet 3 inches, height of port 7 feet 8 inches, displacement 5,711, carrying 980 tons of armour, $4\frac{7}{10}$ inches thick, mounting 8 guns of 9·44 calibre, speed 14 knots. I ought to have said before, in stating the armament of these ships, that I only gave their protected guns, because all of them, both in our own and the French navy, have guns which are not under armour plating, and these I have omitted for obvious reasons. There was a second-class French ship at that date. The ships I have described are first-class, and if you compare the power of the first-class French ship with the second-class English ship, I think nobody will say that there was any very great disadvantage in the English second-class ship if it had to encounter a French first-class ship. The second-class French ship was 230 feet long, beam 45 feet 9 inches, mean draught of water 19 feet 6 inches, height of port 6 feet 6 inches, displacement 3,400 tons; she carried 750 tons of armour-plate varying from 5·8 inches to 4 inches in thickness, and carried four 7-inch guns: speed was 12 knots. With these figures before us, I am at a loss to find in what respects the "Iron Duke" failed in the object for which she was constructed. What was that object? It was to fight on the sea any ship she might meet of her own size and construction, and to give the 450 men who embarked in that ship the means of fighting such an enemy as it might be their duty to engage, on fair and equal terms. I ask whether it is not evident that the "Iron Duke's" class would have fulfilled the purpose for which she was designed, and whether that type can reasonably or truthfully be set down as a failure. The officer who has written this essay founds, as he well may, the whole of his desire for a new type of ship upon

[1] This statement is erroneous—there is not any 8-inch armour above the belt in these ships—the mistake arose from my reading the figures I had taken out for the "Sultan" instead of those I had extracted for the "Iron Duke's" class.—R. S. R.

the supposed failure of the old types. I say there is no evidence of failure whatever, and that their unproved failure does not constitute a necessity for a new class of ship. Something more may be said. It is true that this second-class ironclad is not impenetrable to shot. But what naval architect in this world ever designed a ship that should be impenetrable to all and every shot under all circumstances. No greater error could possibly be committed than to believe that such a thing was ever possible or contemplated. No monitor, no circular-constructed ironclad, no ship ever put together by human hands could, under certain given circumstances, resist the power of modern artillery. But is that a reason that partial and relative protection should not be given? Partial and relative protection against such attacks as it was probable could be made. Partial and relative protection was aimed at in this second-class ship. I have shown you that partial and relative protection has been given to these ships when compared with those of any foreign power that they could have been brought into contact with, because, I need not tell you that at the time when these ships were designed, powerful artillery, and the very powerful ships since built to resist that artillery were not in existence. There is one thing more I wish to say about this ship. The author of this work has been very severe upon the ballast that was put into those ships. One of his objections to them is that they were topheavy. The facts of the case lie in a very small compass, and perhaps I may be allowed to allude to them. These ships were built as lightly in the lower parts as was consistent with sufficient strength, with an express view and intention that they should be lighter than the strict following out of the design would have made them, in fact, weight was spared below so far as it could be spared to introduce it elsewhere. It was known that the work had been carried out with that effect, but how far that work had proceeded could only be known precisely by the trials of the ships. They were tried light; they were not at their load line at the time of trial, and they showed very considerable crankness under such circumstances. But what did this prove? It proved what the constructors of the Navy knew perfectly well, that if their instructions had been carried out in various details, not quite easy to calculate, ballast would probably be necessary, and 360 not 400 tons of ballast was put into them. Now 360 tons of ballast on a displacement of 6,000 tons is not a very great deal. I remember, when I was a young man, I used to see line-of-battle ships going about with 600 and 700 tons of ballast in them. Our old wooden ships, displacing about 4,600 tons, had an establishment of from 300 to 400 tons of ballast. I remember meeting a very magnificent French ship at Lisbon, when your Chairman and myself were in command of frigates there: this line-of-battle ship, with a displacement of 5,000 tons, carried 800 tons of ballast. Therefore, although I am perfectly willing to admit that a slight error was committed, I do not think the adding of 360 tons of ballast to the "Iron Duke's" class at all justifies any condemnation of the type. I admit the necessity for doing so is an error, but it is one of detail in construction, not affecting the type or deserving the word failure as applied to the design. The result of putting in this ballast was to make a difference of about 5 inches in the height of the mid-ship port. It was to have been 8 feet 6 inches out of the water and was reduced to 8 feet 1 inch, and even then the height of the port-sill was more than in the French first-class ship and very much more than in the French second-class ship. The stability of the ship and her sea-going qualities proved perfectly satisfactory. The curve of stability was taken: the ship could be heeled over to 44¾ degrees before she began to lose her stability in the smallest degree, and the stability did not vanish till she was laid over to upwards of 86 degrees. I fancy no one would have the least doubt of the perfect seaworthiness of such a ship, even if the class had not been at sea in every part of the world. The next type is the "Hercules" type, which also has been condemned by the author of this Essay, and if he had not condemned it, he could not have advocated the new type he has brought forward. I should like to compare this type also with the first first-class ship of our own ironclad Navy, and with the French first-class ship, to see whether there is really in her, any deficiency in armament or sea-going qualities, or if the "Hercules," as compared with any sea-going ship whatever she can possibly meet upon the ocean, is under any disadvantage. The first type of our first-class ironclad will be admitted by every one to have been the "Achilles." I put the "Warrior" and "Black

Prince" entirely out of the question as first-class ironclads; but the first first-class ironclad this country did possess was a very beautiful and powerful ship, the "Achilles." Let us compare the "Achilles" with the "Hercules." The "Achilles" has a length of 380 feet, beam 58 feet 3½ inches; draught of water 26 feet 10 inches, height of port 8 feet 8 inches, displacement 9,094 tons. She carried 1,250 tons of 4½-inch armour plating, and under that protection in her battery, 18 7-inch and 4 8-inch guns. Her speed is $14\frac{3}{10}$. The "Hercules" has a length of 325 feet, beam 59½ feet, mean draught 25 feet 4 inches, height of port 9 feet 8 inches, displacement 8,840 tons. She carried 1,239 tons of 9-, 8-, and 6-inch armour, and mounted on her protected battery 8 10-inch guns and 2 9-inch guns, and this ship's speed was $14\frac{9}{10}$ knots. You cannot doubt that the "Hercules" was a very superior ship to the other. The object of designing the "Hercules" was to have a very great improvement over the first-class English ironclad previously designed, and at any rate in this sense the "Hercules" may be said to have been a success. But let us compare the "Hercules" with a first-class French ship. The French first-class ironclad of that date is represented by the "Friedland," the "Marengo," and others. The "Friedland" is 287 feet long, with a beam of 57 feet 3 inches, mean draught, 26 feet 6 inches, height of port 9 feet, displacement 7,180, weight of armour 1,300 tons of 7-, 8-, 6-, 2-, and 4-inch armour. She carries in her protected battery 4 guns of 10·6-inch calibre, and 4 9½-inch calibre guns in towers *en barbette*. Her speed is 14 knots. I do not hesitate to say that there is no comparison possible except an advantageous one to the English type between the power of the two ships; that the "Hercules," or that type of ship, could with great probability of success, and with as much confidence as attends anything human, engage a first-class French ironclad, and engage her with every prospect of being victorious.

The "Sultan" is a little more powerful than the "Hercules," and there is another French ship at sea, the "Richelieu," a little more powerful than the "Friedland." But in point of fact those ships are on the same principles, and an enlargement of type does not mean an alteration of type. Changes in the details of various fittings, and in the constructive arrangement in a ship, do not mean a new type of vessel. It is impossible to suppose that we shall not day by day find out details that may be advantageously applied to our new ships, but because a detail can be better considered now, and be better carried into operation in this day than it could have been five years ago, is that any reason for resorting altogether to another type of war-ship? I say this because in part of the very interesting extracts from the essay which our Chairman gave us, descriptions of additional compartments, an additional number of bulkheads were strongly insisted upon. As to that, every one who has considered the subject for a moment would agree. The more you could divide a ship into water-tight compartments the better; the more you could make her a congeries of cells the better; but it is not necessary by any means to resort to a new type of ship in order to divide her into a great many more water-tight compartments than has been done hitherto, in order to adopt the cellular system as far as possible, and to take the precaution of having all your sea-connections at hand, visible and more perfectly available than in some recent cases they appear to have been. But not only does my comparison of the type of the "Hercules" apply to the sea-going ships of France; my comparison applies also to the sea-going ships of every other country. The type of the "Hercules" and "Sultan" enables us to be perfectly sure that we send our sailors to sea to fight any enemy that they might meet on the open sea with a well-founded confidence of victory before them. The Russians, the Germans, and, strange as it may seem, the Turks have, it is true, one or two ships—that is to say that each of them has got one ship of rather more power than the "Hercules." But there is everywhere the same type, and that type is this,—you protect the water-line of your ship by a belt; you protect the battery and the vital parts of the engines and boilers by armour; you protect your men and guns over a limited space, because you cannot have sea-going qualities if you protect them over an unlimited space. And that is the type of ship represented in small ships by the "Iron Duke's" class, and in large ships by the "Hercules" class, and that is the type of first-class ironclad which throughout the world at this day we shall meet if ever we meet in hostility at sea.

There is one more class I must say a word or two about, before I refer to the ship

that is proposed to sweep away all that we have done, to take a place for herself, and a victorious place, over such vessels as it has been my pleasure to see at sea, and to know something of their qualities. This ship is the "Devastation." The "Devastation" is certainly in some respects peculiar, and I should have expected rather to have heard a word or two in commendation of the "Devastation" from the talented author of this Essay. But no! he dislikes the "Devastation." He reminds me of the old saying applied to Mr. Addington, one of our Prime Ministers:—

> "I do not like thee, Dr. Fell,
> The reason why I cannot tell,
> But still I feel to know full well
> I do not like thee, Dr. Fell."

That is all I can find as a reason for condemning the "Devastation." Well, "kissing goes by favour," and it is very possible that a gallant Officer, who does not like the "Devastation" now, may yet live to see that the "Devastation" has got some very powerful qualities, and is not, after all, to be summarily condemned as an instrument of war. I may say, the "Devastation" takes to sea four of the heaviest rifled guns yet constructed in this country. She takes those guns to sea at a height of fourteen feet above the water. She takes them in two turrets, protected by 14-inch armour. The hull of the ship that bears those turrets is protected by 12 and 10-inch armour. There are bulkheads, which cut off all access of dropping shot from the vital parts of the ship. She has a speed of 13·8 knots; she can reverse her powerful qualities as a ram in two minutes and two seconds—that is, she could be charging in one direction at the rate of 16 statute miles an hour, and in two minutes she could be charging in the opposite direction at the same rate of speed. She has been in gales of wind on the Atlantic; she has been exposed to such weather as she could find on the coast of Ireland; she has crossed the Bay of Biscay; she has done good service in the Mediterranean, with eminent satisfaction to everybody on board. She carries 1,200 or 1,400 tons of coal, and the radius of her operation is only measured by the distance that coal will carry her. At ten knots an hour, she will go upwards of 3,000 miles without exhausting her fuel. I am unwilling, therefore, that so valuable a type of British ironclad should pass under, what I consider, the indiscriminating and undeserved censure of the gallant Officer who has written this Essay; because, as a British sailor and a British Admiral, I feel convinced, if it ever should come to pass that our fleet should be tested, the account that the "Devastation" will give of herself on the day of battle will dispel a cloud of, what I venture to call, prejudice, which still hangs over her.

Now, I have described the three types of ships which have been absolutely condemned by the author of this Essay, and on which condemnation he has founded the only type of battle-ship he has proposed to use; and I am about to make some few observations on the type he has advocated. First of all, I may say, if he was right in his condemnation of these old types, I consider he was perfectly right in proposing a new type. It is for that reason I have dwelt so long upon the valuable qualities of the old types, because I think, if my position were entirely wrong, if it were true that these types were not at all valuable, and deserved what he has said of them, it would be absolutely necessary, without delay, to invent a new type; and that many disadvantages that we might otherwise find in his proposed type ought to have little weight in our judgment, seeing the pressing and urgent necessity of adopting a new principle. Now I have got an observation to make upon this new type of ship. The author has not given us many details, but we all know that, to judge of the qualities of a ship proposed to us, a great many calculations must be entered into, a great many statements must be made, before we can simply adopt or reject the idea of the ship presented to us. The details that he has put forward as to the rudder, and various things of that kind, are all exceedingly good in their way, and, no doubt, perfectly applicable to old types as well as to new. His principle, as far as it is developed, is this: He says, speaking of the old types, "The "ship is only partially and imperfectly defended, and the partial and imperfect "defence of the battery and of the guns has led you to cover the vital parts of "a ship with an imperfect protection also. I will do away with that; I will remove "the imperfect protection you have given to your gun and armament, and I will

"apply it to your water-line." What do we find? The first thing I find that the Essayist proposes to do, is the very thing that he has found fault with as exemplified in the old types, namely, "imperfect protection." I will show you at once how it is. He takes two classes of his proposed ships, and he gives you a belt of 14-inch armour for the first-class ship, and for the second-class ship 10-inch armour; and, to my surprise, it is to taper, 100 feet from the stern of the ship, to one-half its entire thickness. Thus, this 10-inch armour is to taper to five inches at the bow, and at the stern it is diminished by twelve inches, so that under the counter he has only two inches of armour. Now, it is undeniable, that tapered armour plating is, in a certain sense, a defect; for a ship is not so strong with armour tapered as she would be with armour of the same thickness all over the ship. But it is an inevitable necessity, and we all lament the necessity which prevents us from protecting the extremities or any part of a ship with 10 and 12-inch armour, while we can defend her sides with 12 and 14-inch plates, but it is an inevitable law of nature, of universal application. Well, in this Essay we find ourselves condemned for having tapered the armour plating in the old ships because of its imperfect protection, and here is the new ship with a greater taper than we ever ventured on in the old ships. Therefore, the imperfect protection, instead of being cured in this new type, remains an imperfect protection still, and liable to be pierced and to be destroyed at that very water-line, to defend which, he is so ready to make sacrifices. But let us see what these sacrifices are. We have sacrificed the imperfect, though very considerable, protection that we gave to our artillery and to the men who work the guns. The Essayist takes away the whole of the armour from the guns and from the men. Now, as has been said at the beginning of this discussion, the whole object of an ironclad is to contend on equal, or even on better, terms with another ironclad. If nobody in the world had ever built an ironclad, I do not know that we should have done so; but what we did feel was, that as long as anybody else had got such a weapon, imperfect as it was, full of faults as it was, still such a weapon was so powerful, that a similar weapon must be provided to contend against it on, at any rate, not unequal terms. We ask no more. We do not ask, because it is not possible, to go about in impenetrable ships, free from all hurt to ourselves while dealing destruction around us; but we ask that we shall not be caught at a disadvantage, that we shall have a ship as good as anybody has, and then we, under Providence, will answer for ourselves. But here the Essayist, in order to procure this very imperfect protection at the water-line, takes away the whole protection from the men and from the guns. I ask any one for one moment to consider what the effect of a broadside of the "Sultan's" 10-inch guns would be upon that war-ship which he has described, a ship which will carry, I admit, one-third more guns than the "Hercules" does, because the "Hercules'" battery is limited to the protection we can afford to give it by armour, and the battery of the new ship is entirely unprotected, and, therefore, might oppose fifteen guns to the "Hercules'" ten. But what would be the result at 1,200 yards of shot from the 10-inch guns of the "Hercules" striking against the battery of a ship built, as the Essayist proposes, of thin iron. Has any gentleman ever seen a target representing the unarmoured side of an iron ship, and noticed the effect of the shell striking that target? If he has, he will say with me, that the ravage it commits is fearful to look at. And then, as there is no limitation, no concentration of the armament of such a ship, but as the guns are spread pretty nearly from one end of the ship to the other, the aim of the opposing gunner will be very much easier; he has a much larger object to fire at; he is not bound exactly to fire at the centre of the protected part of the ship. To do any damage to the protected battery, the fire must be directed to that spot where the space is limited and the execution uncertain; but against the unprotected battery he has only to hit the ship somewhere above the water-line, and he kills men by scores, sweeps the decks, destroys the guns, and ruins the structure. I confess to have very great regard for the gallant Officer who has written this admirable Essay, I hope that his talents may be profitably employed for the benefit of his country, I wish that every good may befall him in his profession, and that he may rapidly rise to hold high command in Her Majesty's ships; but this I should regret; I should regret nothing so much as to see him in command of a British war-ship, manned with 600 men, defended in the manner he has described here, and of the

type just referred to. If he went into action, I should shake hands with him, knowing the unavailing gallantry he would certainly display, but I am perfectly certain that I should never see him again.

Although I am very far from having exhausted the observations I might make upon this type of ship, I must draw to a conclusion; and although one of the very strongest points of my objection to the type which he has so ably advocated is this, I can only just hint at it; supposing that the armour-plated belt rises 5 feet above the water-line, there are the uptakes, crowns of the boilers, the whole motive-power of the ship absolutely undefended either from direct or indirect fire. The ship is defended in the most inconsistent way possible, and one might almost smile if such a subject as this could be treated in any way except seriously. She is almost undefended from raking fire; for strange to say, after all the objection the Essayist has made to the partial protection afforded by her armour-plating, he has himself, in this very new type that he introduces to our notice, put up what he calls a thin bit of armour at the bow and stern. What effect can a thin bit of armour have in resisting such shot as those of the 12-inch guns of the "Devastation" and of the 10-inch guns of the "Hercules?" A shot fired with any sort of command of height above where the armour plating stops in the ship, travels where it pleases, does what it likes; and I am sorry to say, as effectually condemns that type, and more clearly than any words I can produce. One would have thought Captain Noel would have had a word or two to say in favour of the "Inflexible" type, but no: he has studied the "Inflexible" type, and he finds that her "balance"—a term which, without meaning any discourtesy to the gallant officer, I have in vain endeavoured to understand—is such that on the water being admitted where it may be admitted if the ship is penetrated by shot, the result will be very unfavourable. Accordingly, he dislikes her exceedingly. Now I am not competent to stand up and speak of the qualities of the "Inflexible." She has been designed by those gentlemen whose application to this subject, and whose excellent mode of studying those questions in every way, I have long known and appreciated, and therefore I think I may say with well-founded confidence that I have the highest and strongest belief that the "Inflexible" has been considered in every point, that this "balance," which is to worry them a great deal, has been properly considered, and the "Inflexible" will turn out in every respect one of the most formidable instruments of war ever seen upon an ocean. I see one or two gentlemen connected with naval construction in this room, and it rather prevents me from saying a word or two which I should very much like to say as to their talent and power to advise and design all that is wanted for the British navy. I know this well, having received many proofs of it, and can speak with perfect impartiality in that matter. But they are present, and I do not like to praise them very much to their faces. So about that I shall say no more. One or two of them no doubt will take up the subject of the "Inflexible," and say what I am not able to say from want of proper acquaintance with the principles of her design. The author of this Essay may perhaps endeavour to justify in some measure the new type of ship by an allusion to the "Shannon," therefore I wish to make the whole of my observations complete by referring myself to that ship. The "Shannon" partakes in many respects of the type of vessel he has proposed for an ironclad warship. Those gentlemen who are responsible for our Navy, and the present Controller of the Navy, one of the most practical and thoroughly experienced seamen in our profession, will tell you that the ship was not designed as an ironclad at all, that she is a special vessel of war for cruising in distant regions, protected at the water-line and other places; never intended to be reckoned as an ironclad, but intended to protect our commerce wherever that commerce may be, and to meet any unarmoured vessel not only on equal terms, but on terms that will ensure victory. The "Shannon," with her co-mates, was not designed as an ironclad, and does not rank as an ironclad at all, because they are cruisers with an armoured belt at the water-line. That does not show that they are in the least intended to take the place of an ironclad warship; nor can such a type of vessel, in my opinion, ever by any means take the place of an ironclad on equal terms when she has to engage another. The various remarks that the Essayist has made about circular ships I must leave others to deal with. Of this I am perfectly sure, the circular ship presents very remarkable features for special and

limited purposes. The circular ship is being studied by those naval architects and constructors who are perfectly capable of dealing with the question in every way, both in its practical construction and as to the scientific requirements which every vessel that floats on the sea ought to have. Therefore, as I am not in a position to go into these details, having occupied your attention far too long, I shall say no more upon that subject. I will not allude further to the sailing and unarmoured cruisers, for it does not appear to me, on reading the Essay carefully, that there is suggested anything remarkably new. He has not suggested any new type; and with the exception of certain details which are extremely well thought out, and which after all are being carried out more or less successfully in every new ship, the whole marrow, pith, and kernel of this essay is the new type of ironclad to engage the enemy's ironclads. I think I have given this meeting sufficient reasons for not believing that that new type ought to be adopted. However great the merit, and however much we may be indebted to the gallant officer for his production, I believe that we cannot be wrong in decidedly (as I have done) condemning the new type as an ironclad vessel of war able to contend with other ironclad types. I hope in the remarks I have made that I have strictly guarded myself from saying anything which might appear offensive, or calculated to give pain to any one, but if I should have done so, as I said at the beginning, I should wish to apologise for it, and to say again that nothing could be further from my wishes or intentions. I beg to thank you for the attention with which you have listened to me, and now bring my remarks to an end.

Mr. BARNABY, Director of Naval Construction: The matter discussed in the paper is so extremely important that I trust you will not be tired if I speak for ten minutes or a quarter of an hour on the subject. I find that the ships which have been put forward of new types by Captain Noel would cost about 21 millions of money, and I suppose, therefore, we ought to be prepared to discuss pretty fully his plans before we go so far as to condemn that which we have already, and agree to enter upon so large an expenditure of public money. The ten first-class ironclads which he proposes would cost about 4½ millions, the twenty second-class would cost about 6 millions, and the four coast defence ships would cost about 3 millions. The six of the second class of coast defence would cost about 3 millions more, making altogether forty ironclad ships, at a total of 16½ millions; and then there are besides twenty-four cruising ships, costing 4½ millions, making altogether 21 millions. Sir Spencer Robinson has said already enough about the "Devastation" to justify me, I think, in saying nothing about her, although I proposed to commence my observations by some remarks about what Captain Noel calls "coast defence ships." I must confess I was astonished beyond measure to find reckoned with those coast defence ships not only the "Thunderer" and "Devastation," but also the "Dreadnought" and the "Inflexible." The "Dreadnought" is a ship with a belt of armour rising everywhere 4 feet out of the water, with a deck running right fore and aft 11 feet out of the water, with 14 inches of armour and 14 knots speed, and with a draught of water that puts her altogether out of the list of coast defence ships. Why she should be reckoned among coast defence ships, and considered not to be a first-class fighting ship, I cannot imagine. I can understand why he excludes the "Inflexible"—he does not believe in her. If you would give me a minute or two, I think I can show you what it is he fails to understand, because it is really very easy to be understood. I cannot conceive exactly what his language is meant to imply any more than Sir Spencer Robinson can, but I think I see enough of what he means to show you where his error lies. Suppose this central part of a ship (Fig. 1) is an armoured part, and these two ends are not armoured, but that underneath these two ends—that is, under the water-line—there is a shot-

Fig. 1.

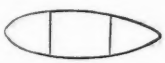
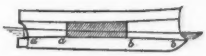


Fig. 2.



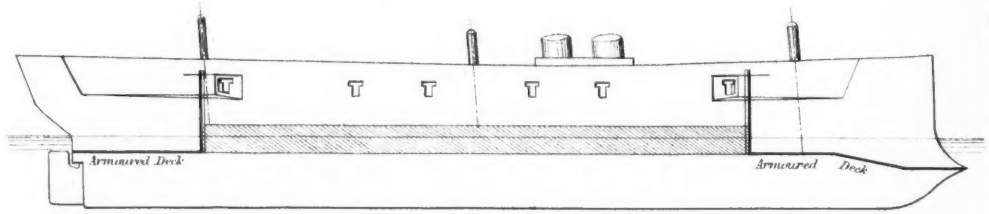
proof deck. Now look at her the other way (Fig. 2). Taking the upper deck of the

ship 20 feet out of the water, and the fighting-deck 10 feet out of the water, the armour goes up to the fighting-deck and comes down under the water; and there is a shot-proof deck continued under the water in both directions towards the stern, *a a*, and towards the bow, *b b*. If she were light and had not her proper allowance of coal, this shot-proof deck would be 4 feet under the water, and the fighting-deck would be 12 feet out of the water. You will see that the areas of these two parts are together nearly the same as the area of the centre part. Imagine now that you have perforated this thin plating, and filled the two ends of the ship between the shot-proof decks and the water-line with water. Suppose, in other words, that these spaces are quite empty, and that when you let the shot come in they get filled with water. Now, says Captain Noel, there is nothing to hold the ship up, except the part under the shot-proof decks. What he means by that I do not know. What is obvious is this: inasmuch as you have lost the buoyancy which is due to a body of a certain area, 4 feet thick, you may take this central body, which is armour-plated, of the same area, and if you take a layer of that 4 feet thick, it is quite obvious if that 4 feet goes down into the water you have done all that nature asks you to do. The buoyancy has been lost of the 4 feet abaft the citadel and the 4 feet before the citadel, and she asks you to give up 4 feet more, *i.e.*, an equivalent bulk of the unpierced part of the ship not previously immersed, and what you will have now is a ship with a fighting-deck 8 feet out of the water, and with a shot-proof deck 8 feet under the water, instead of that which you started with, viz., a light ship with the fighting-deck 12 feet out of the water, and a shot-proof deck 4 feet under water. But this is not the actual ship. The ship is this. Let me ask you to imagine now that she is, as she might be, loaded with her stores; the fighting deck would then be 10 feet out of the water; she has been pushed down 2 feet, and the shot-proof deck is 6 feet under the water. Suppose, first, that this 6 feet under the water had been filled in solid with timber. Now will you tell me what will happen when I shoot into it? Why should the ship sink? All that will happen will be that so far as the shot ploughs a hole into the solid timber so far a small quantity of water will go in, but only to fill up the hole actually made by the shot. But you say, "The 'Inflexible' has not got a bow filled in with timber like that." No, but she is filled in with something which excludes water three-fourths as well as timber does; she is filled with fuel there, and if the ship is filled with fuel, in sea-going trim she is brought down in the condition you see, and she excludes water, even although you punch shot through her from one end to the other of those two places. Or suppose, on the other hand, she were perfectly light and there were no divisions—I need hardly tell you the whole of the unarmoured part is divided into numerous compartments at both ends—but even supposing the ship were light, and there were no fuel and no divisions, then after perforation of both ends, instead of having a ship with 10 feet height of battery out of water, you would still have your ship at the very least with 8 feet out of water. What is there incomprehensible in that? What can Captain Noel mean by saying that the ship's safety depends on the part under the shot-proof decks keeping out the water? It is the armoured citadel that keeps her up to the surface, and the fact that the unarmoured ends of the ship are filled in with fuel, and exclude the water.

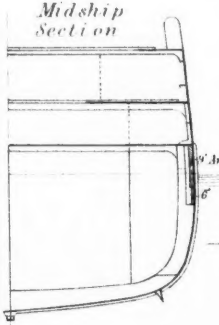
Now one word about cruising ships. Some tables are given about the exact weight of the armour of the belted cruising ships. Perhaps you will take my word for what I am going to say—I can prove it if it is necessary—it is that Captain Noel has made a curious error. I do not know precisely whether it is that he has omitted to multiply by two, but I think that is what it is; at any rate the weights of armour he has given here are, taking the least estimate you can, half what they ought to be. Take page 15. Any one who will multiply 300 feet by 2 for the two sides of the ship, and will multiply that by 8 for the width of the belt, and will multiply then by $4\frac{3}{4}$, that being the average thickness of the armour, then by 40, that being the weight of a square foot of 1-inch plate iron, and will then divide by 2,240, will discover that instead of having 202 tons, he has about 410 tons. I do not think it quite fair to us to give us, as the design for a ship, no other particulars as to weight than these. I am therefore obliged to pass from his belted cruisers with this remark, that I think Admiral Stewart would call that (pointing to a model of the "Nelson" and "Northampton") our belted cruiser. We have not used the name, but Sir Spencer Robinson has already said the "Nelson" and "Northamp-

NELSON & NORTHAMPTON

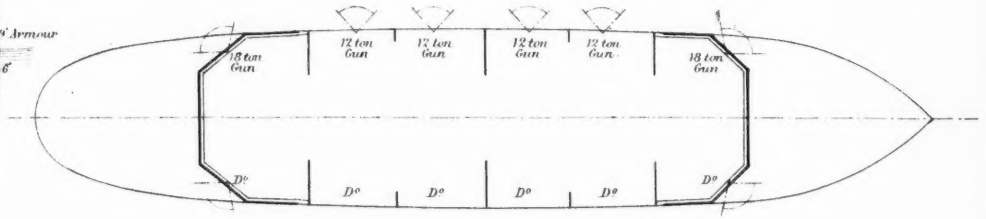
Profile



Midship Section



Plan of Gun Deck



J. Johns

ton," which is in fact very much the same as was described in this room three years ago, and of which there is a drawing furnished by me in the XVIIth Volume of the Journal for 1873, agrees pretty nearly with the ship proposed by Captain Noel for his first-class battle ship. Those ships ("Nelson" and "Northampton,") are in fact very much the same size as what he calls his first-class battle ship, but they have only 9 inches of armour, whereas for his first-class battle ship he proposes to put 14 inches. They differ from his ship in that they have no belt armour at the ends. He proposes, as Sir Spencer Robinson has told you, to make his belt armour at the stern only 2 inches thick. We do not like 2-inch armour at the ends if we can get rid of it, and so what we have done is to put at the two ends of the ship stores and fuel, which will exclude water, even if perforated; but in the "Nelson" and "Northampton" you find at the stern you get 9 inches of armour, at the bow 9 inches, and anywhere along the belt the same thing. They differ from his ship also in this, that the guns are protected from bow fire by 9 inches of armour across the bow. The belt is one foot narrower than his belt; the armour 9 inches thick instead of 14; the displacement of the ship 7,300 tons, whereas the displacement which he puts down for his is 7,500 tons; the ships are therefore about the same size. But he says he only wants 700 tons of armour for his ship, which is for the line-of-battle: the "Nelson" and "Northampton" carry 1,700 tons, and they are only belted cruisers.

Sir SPENCER ROBINSON: Is there side armour?

Mr. BARNABY: Side armour to the bow guns and to the stern guns. The armament is two 18-ton guns firing astern and on the broadside, and two firing ahead and on the broadside. There is therefore a broadside battery of two 18-ton guns, protected by 9 inches of armour on each side, and the intermediate guns are 12½ tons. The midship part is unarmoured, and I am in the unfortunate position that I am committed to some extent to the same idea as that of Captain Noel, which has been handled so roughly by Sir Spencer Robinson. All I say is, whatever can be said for Captain Noel's ship may be said much more strongly for the "Nelson" and "Northampton." His second-class ironclad is only to have about the same thickness of armour as these ships have, but what I have told you about the armour will be sufficient to show you that you cannot place any reliance upon the figures you find there. It is my duty to say that, and I say it, but you will understand that an officer in Captain Noel's position cannot be where he would have an opportunity of going as carefully into a matter of this kind as we should have in London. It takes all my time, by night and by day, to make myself master of the details of my profession, and I am not in the least surprised that he, clever sailor as he is, trips sometimes when he comes upon our ground.

Sir SPENCER ROBINSON: Are the broadside guns to be on turntables?

Mr. BARNABY: No; the idea is that the only protected guns are to be these four 18-ton guns. If this ship is engaged in close action with an ironclad, which she may have to be, although she is not designed as a battle-ship, then naval officers know how these guns may be laid and fired in a broadside without exposing all the gunners necessarily, either on one side or the other, to the enemy in passing. There is a magnificent bow-fire from behind 9 inches of armour; there is also a magnificent stern fire, and you will see Captain Noel gives no protection whatever against stern fire. And if it should happen that this ship has to engage an ironclad, these four midship unarmoured guns can be laid, and you can place yourselves in a position where your enemy cannot get at you, and fire them in a broadside. You get therefore the advantage of a large number of guns for which he contends; you get your isolated batteries which, though Sir Spencer Robinson does not seem to approve of, is to my mind undoubtedly an advantage. Inasmuch as the bursting of a shell in a single battery may be serious, the splitting up of the guns into several batteries commends itself certainly to my judgment. The cost of the hull and engines of one of these ships is £330,000; and I should like to say in that connection another word about coast-defence ships. £330,000 is the sum of money which it appears from Captain Noel the Russians have paid for the "Novgorod," and he seems to consider the "Novgorod," which mounts two 28-ton guns, is a ship to be commended, having cost £330,000, and he comes here to say that he thinks we should build ships, not of 2,500 tons,

but of 8,500 tons of the same kind. These ships would cost three-quarters of a million of money each. I would say with regard to the "Novgorod," which he says cost £330,000, you shall have twenty gunboats going nine knots an hour, carrying a 25-ton gun, for the same money. Which will you have? But Captain Noel does not contend for a "Novgorod" in the Russian style; he contends for it in Mr. Elder's form. But in Mr. Elder's form he introduces a difficulty which Admiral Popoff has avoided to a great extent. For if the things are slow, and they will be, and if they are attacked by boats that are fast, and they may be, and these boats have torpedoes, which they will have, there is a nice little shelf there under which you can put the torpedoes. With regard to the battle-ships, I only remind you that this ship, which we call a belted cruiser, makes up her 7,300 tons in this manner—2,800 tons weight of hull, 2,800 tons of engines, guns, stores, coals, 1,700 tons of armour (vertical and horizontal), and that will make 7,300 tons. Now Captain Noel tells us that this ship, with 14 inches of armour, is going to be built with about that total weight; and he is going to do it with 700 tons of armour. He is going, moreover, to put a vastly heavier armament in the ship. I think I have said enough to show that I do not altogether agree with Captain Noel.

Sir SPENCER ROBINSON: I think Mr. Barnaby misunderstood me when he said I disliked separate batteries;[1] it is the very thing of all others I like most. What I do object to is an unarmoured battery for an ironclad.

Lieutenant MERRYON, R.N.: May I be allowed to say a few words, after Captain Noel has been so roughly handled, on his behalf? I quite agree with what Sir Spencer Robinson said about the success of the "Audacious" and her class, in answer to Captain Noel's expressed opinion of them as failures. But Sir Spencer Robinson and Mr. Barnaby did not allude at all to one point in Captain Noel's Essay that I think is a very notable one, and that is, Captain Noel points out the very great inutility of bow-fire, to which so much importance has been given in most of our ironclads, at the expense of considerable loss of armour in the foremost angles of their batteries. When you consider two hostile fleets approaching each other at great speed, with the captain of each ship's nerves fully stretched to keep his station, and watching his compasses, if he is a leader of a division, to keep his course exact, so as to bring his division into contact with the enemy in as perfect a formation as possible, what would be his irritation to find a gun going off right under his nose when he least expected it, setting all his compasses swinging, and obscuring the enemy for a few most valuable moments; and, finally, the system of attack not likely to be doing any harm to the enemy at all, as the shot would be striking on, or glancing off, the thickest defended part of the enemy's ship, that is, the bow! I think too much value has been placed on this bow-fire; it is practically useless, except in the case where any of our ships might take the ground when in action with shore batteries.

Captain BEDFORD PIM, R.N., M.P: I should like to move the adjournment of the discussion. The subject is a very important one, and the hour is now getting rather late. I beg to give notice that at the adjourned discussion I shall move the following resolution: "That this meeting is of opinion that the Essay of Commander "Gerard Noel, R.N., for which the Medal of this Institution has been awarded this "year (1876) bears the impress of hasty and ill-considered compilation, and does "not point out the best type of war-vessels for the British Navy; 1stly, for com-"bined action; 2ndly, for single cruizers of great speed; thirdly, for coast defence."

The CHAIRMAN: I must beg to inform you that it is not competent for you to bring forward such a motion in the theatre.

Captain SCOTT, R.N.: The subject before us is a very important one, and I feel strongly that we have only touched the edge of it. I think that more extended diagrams should be brought here, and that what we should discuss is the gradual development of our fleet, how it may be improved, and the direction that improve-

[1] The separation of the guns in the batteries by the traverses he has described. On the contrary, it meets my entire approbation. Something not unlike this arrangement, was made in the "Bellerophon," under Mr. Barnaby's directions. What I objected to, is classing ships with unprotected batteries as ironclad ships of the line.—R. S. R.

ment ought to take. I look upon these as points so very important that they cannot be too much ventilated. I will, therefore, second the adjournment.

Sir SPENCER ROBINSON: If the debate is adjourned, it must be upon the Prize Essay.

The CHAIRMAN: I quite agree. We must stick to our subject. There are plenty of opportunities of going into the other questions. We must understand that the adjournment is for this, and we must endeavour to keep and speak to this as much as we possibly can.

(Adjourned to the 30th inst.)

ADJOURNED DISCUSSION.

Thursday, March 30th, 1876.

ADMIRAL SIR HENRY J. CODRINGTON, K.C.B., in the Chair.

The CHAIRMAN: Before re-opening the discussion I wish to say a few words on two or three points. The first is the necessity of confining the discussion to the purpose for which the meeting was summoned, viz., the Prize Essay. It is the only way in which we can make our proceedings keep within bounds. The next is that there has been some expression about the province of those gentlemen who have been kind enough to undertake the laborious and difficult duty of umpires in deciding on the Essays of candidates for the medal. It should be well understood that those gentlemen have undertaken a certain duty, namely, to decide, out of the various Essays which have been brought before them, which is the one that they consider on the whole, after duly weighing the various merits of all, is worthy of the Gold Medal of the year. It does not at all follow that the umpires advocate any particular points in that Essay; they are merely deciding on that which they consider the best essay, in order that the Council may give the medal to its author; but they are not responsible, of course, for the particular opinions given in those essays. However, we may rely upon one thing, that the high character and long professional experience of those Officers, who have been kind enough to undertake that very difficult duty both in the case of the Army, and of the Navy medal, is sufficient warrant for us to feel well assured that they have adjudged rightly on the point on which they did judge.

The next point I wished to mention was, that an idea has been put forward by a gallant Officer about moving a resolution. We should well understand that there is no power to do anything of the sort at these meetings. We meet here—the members of this Institution, and their friends, and any gentlemen whom they invite, anybody who can give us information on the military or naval questions under discussion—and there is a free course for discussion on all these points. But we are not a general meeting of the members, nor are we in any way authorised to pass resolutions; in fact it would be illegal if any meeting of this sort were to attempt to pass resolutions.

Sir SPENCER ROBINSON: Before the discussion commences I beg leave to ask one question. You have stated,—and I am sure I am extremely obliged to you, and I should think every member present is extremely obliged to you,—the part the referees

had to take, and how far our discussion was limited by the manner in which they had discharged the function they were called upon to perform. May I ask was any naval architect consulted in awarding the merit of this essay?

The CHAIRMAN: I do not know that I am in a position to answer that question in any way. The Council invite three members, either of the Army or Navy, as the case may be, to undertake this duty, and I can assure you it is a very difficult duty indeed. In the case of the military medal there were seventy-nine Essays, and the referees with many other occupations, some official and many private, had to read those seventy-nine Essays thoroughly well through, then they had to meet and give their opinions. The naval Essays were not nearly so numerous, from whatever cause it might be, but I apprehend it is entirely in the breast of those gentlemen whether they did or did not consult any other persons. At any rate, I am not able to say.

Sir SPENCER ROBINSON: If you could have told me that a naval architect was consulted, I should have been very glad to hear it.

General SCHOMBERG, R.M.A.: I hope I shall not be considered presumptuous in venturing to speak on this subject not being a sailor, but the Officers of my branch—I won't say my brother Officers, because we either are, or ought to be, all brother Officers—may have to fight in those ships, and I naturally feel and always have felt a very great interest in their construction.

We cannot put an iron case on our own feelings and everybody who has been in office, I suppose (as I have), wishes very much he could; but however difficult it may be, I think as little personal feeling as possible should be shown in considering this very grave subject. We live in a time when there are changes almost daily in artillery. The whole system of warfare is revolutionised. Therefore, I think when a new class of ship is proposed this should not be construed into an attack on by-gone ships, which have been, perhaps, perfectly suited to by-gone times. We are proud of our mechanical powers, but I do not think we have any so perfect piece of mechanism as the old line-of-battle-ship was, to do what she had to do before the days of shell-guns and steam. We are now trying hard to get something which will do as well, and it is a very difficult task. I think, therefore, it should be a subject of gratification to the Naval Service that a young Officer in its ranks has brought forward his views on this subject with so much modesty and intelligence as Captain Noel has done.

The expressions "success" and "failure" have been used very often. We ought to qualify them with the adjective "probable," because none of the iron ships that have been yet constructed have gone through the fiery ordeal of action, and until that takes place I do not think we can talk of "success" or "failure." We can only guess, and he will be a very clever officer indeed who will prophesy what the outcome of a naval engagement will be.

I will now come to Captain Noel's proposed ship for combined action. I perfectly agree with the main principle he starts with, that looking at the great changes which have taken place in artillery, the first object to be sought for is that a man-of-war should be unsinkable, if possible. I think this is the first desideratum; and even protection to the gunners, speed, and coal-carrying power are minor points compared with it. I feel the greatest satisfaction in seeing the drawing of the "Nelson" and "Northampton," which very nearly carries out his views. I, for my part, would much rather go into action in a ship of that sort than anything we have constructed yet. I think we would all rather run the chance of being smashed than the almost certainty of being drowned like rats.

I agree with Captain Noel's opinion that the value of bow-fire has perhaps been rather over-estimated. I think when two fleets are closing (of course this is all conjecture), probably very few guns will be fired, and the fewer the better. But I also think he has disregarded protection to the bow and stern; and I would rather sacrifice some of his increased armament to get what in fortresses are called "traverses," and in ships "bulkheads," which would give a certain amount of cover from the raking fire to which ships may be exposed.

The next subject is the guns themselves. I think all those guns should be on turntables, and if they were placed on turntables I believe you need expose very few men on the gun-deck: all the traversing, and running-in and running-out, might be done

on the deck below. So that the only men who would be exposed would be No. 1 and perhaps four or five men to load, who might also be under cover when not actually engaged in serving the guns. There is also one other point Captain Noel has rather overlooked, and that is strengthening the deck that covers the boilers, powder magazine, and the men.

The proposed steering apparatus (I speak with great hesitation) seems to me rather weak.

As to the cruisers of great speed, the subject is rather off my line, but I submit that the proposed belt might probably diminish the speed under sail; in war there must be great difficulty in getting coals, and everything that takes away sailing power must be a disadvantage to a cruizer.

As to coast defence, I will not enter into the point whether the "Devastation" is more calculated for coast defence than for cruizing: she is the only one of her class that has been afloat, and I think the main point of Captain Noel's objection is correct —that she seems to have too small a margin of flotation. She is perfect if she has not a hole in her skin, but what will happen if her skin be pierced no one can say.

Then I come to circular ironclads—I should be very sorry to call them "ships"—I think if you call them "circular batteries" such movable batteries might be of immense use for the defence of the Thames, Mersey, and our other rivers.

If we do not organise the defence of these rivers and hives of industry before war comes, it can never be organised when war does come, and Liverpool and other ports will be burned to a certainty.

My idea of a gunboat for the defence of the coast of England is a vessel that can take the sea in any weather and carry the heaviest guns—I do not mean the monstrosities in the way of guns we are now trying, but 35-ton guns. Such vessels as could also keep the sea and rendezvous off Beachy Head or the coast of Ireland in any weather are what we require.

There is one kind of vessel that has been entirely forgotten, and I am afraid the piece of ordnance she has to carry is also forgotten; that is, the mortar-boat. We have no 13-inch rifled mortars, and I think it is a pity that we have not, because England's power of defence rests in her power of offence, and with 13-inch rifled mortars I believe we could burn a good many arsenals and dockyards which are considered unapproachable.

Captain Noel has made a comparison of our fleet with that of other nations. Now I won't say whether such a comparison is judicious, but when a comparison is made, I think the conclusions drawn from it should be correct. In the old days of line-of-battle ships if we had 100, France 50, and Germany 30, we could attempt to draw comparisons of naval strength. A line-of-battle-ship was a unit of strength that we could perfectly understand. We knew she could only be sunk (barring the force of the elements) by a line-of-battle ship. We cannot say that now with regard to the new ironclads, which a gunboat might sink; therefore such comparisons are not correct. For this reason it is imperative that we should have a very, very large reserve of ships. In looking at Schomberg's "Chronology" before the commencement of the war of 1793, I find that, roughly, we had 129 line-of-battle ships, 129 frigates, and about 100 smaller vessels. That force was a much greater naval force than we have now. This subject, reserve of ships, is one that requires very grave consideration.

Captain R. A. E. Scott, R.N.: General Schomberg has just spoken of comparisons, but it is exceedingly difficult to institute any satisfactory comparison.

Unless England can maintain her maritime superiority she must cease to be a great power amongst nations; therefore, what she wants is, first, the maximum of efficiency in her armaments, and, secondly, the minimum of cost.

I find at page 16 of Captain Noel's pamphlet, great prominence is given to the arming of ocean mail steamers as a sort of supplement to our naval force in time of war. I think any such expedient would come too late; it would be a similar mistake to that made at the commencement of the Crimean War, when, instead of utilising the steam tugs by at once preparing them as gunboats, it was unfortunately decided to *build* gunboats, and we all know with what result. Now things march on a great deal faster than at that time, and unless we are thoroughly ready when war breaks out, we could not afterwards recover the lost ground.

England, as a first necessity, must be prepared to maintain her lines of traffic with India and her colonies unbroken, and this can only be done, *not*, as some have supposed, by removing our merchant steamers from their legitimate trade, but by preserving this trade by rendering our merchant navy which carries it, a navy militant, by giving them a thorough and intelligent training in times of peace.

It is necessary I should refer to this matter, because when one speaks as to what class of cruizer is the most needed, one has to bear in mind what cruizers have to do, or rather, as I hold, what our war cruizers must supplement, which is our *armed* Mercantile Marine.

This force, kept fully manned by its own crews, is essential to preserve our commerce, which must furnish the sinews of war.

Once interrupt our trade by taking away from the merchant steamers their able seamen who are now the Royal Navy Reserve men, and you would destroy your own resources.[1]

The Reserve men must be retained in our merchant vessels, their (Reserve) Captains commanding them, and thus keep their own ships really prepared at all times to meet an enemy's flying cruizers or privateers.

Remember what Raleigh, Drake, and others did of old. How they in poor vessels were a terror to Spain. Look at what our sailors did in many a cutting-out exploit, and are not our British seamen able to do the same now? Let every passenger ship, then, be prepared to defend herself, her passengers being armed with Snider muskets and the sailors provided with light guns, torpedoes, and Gatlings, and thus you have at once your first line of defence—a line which must be maintained at all hazards unbroken. If our foreign trade were to be interrupted, England would soon be left without commerce.

A great deal has been said about the desirability for the multiplication of lightly armed British cruizers, but our cruizers must constitute a strong sea police, and be prepared efficiently to support and protect our Mercantile Marine against capture by real war ships.

We may talk of fighting in squadrons, or in any other settled manner, but that would probably not be the way in which an enemy would attack us. For instance, if we were prepared with very heavy vessels to fight only in the Mediterranean, that is not where the enemy would go, but he would instead send his powerful ships to distant seas, and attack us there. In that case if our cruizers were weakly armed vessels[2] of what use would they be? Are they to run away from every small or seeming ironclad? Certainly not. They must remain and fight to protect our mercantile lines of traffic, keeping up constant communication with each other, so that if any point in these lines is menaced, it may be made known and defended by a sufficient force.

Captain Noel speaks of having the cruizers, proposed in his Essay, *belted*. The "Nelson" and "Northampton" are belted ironclad cruizers. The question now in dispute seems to be, whether our cruizers are to be really efficient for fighting purposes, or to carry small guns only at a high speed. I think a lightly armed cruizer would be of little use in warfare, for our merchant vessels could give a good account of privateers who would find they had caught tartars if these were handled as they ought to, and I expect would be, by well trained Reserve seamen, commanded by well trained Reserve merchant captains.

Granted this, and it will then be only necessary for our cruizers to be equipped to fight with actual men-of-war; hence we should build cruizers of sufficient size and power to be useful in all seas and under all circumstances. The question therefore arises as to what, on the whole, will be the most efficient and economical vessels for such services.

The "Nelson" and "Northampton" in some respects meet our naval require-

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[1] On the declaration of war it would, I believe, be necessary for Government to give a guarantee for the payment of the excess of insurance caused by hostilities, so as to prevent English goods from being carried by neutrals.—R. A. E. S.

[2] The "Iris" and "Mercury," of large size and enormous speed, will only carry 64-pounders into action.—R. A. E. S.

ments. They are belted cruizers, and men's minds are going in the direction of putting some armour on cruizers.

Sir Spencer Robinson told you at the last meeting in this theatre how the thin sides of an unarmoured vessel built of iron would be driven in by shot, and be cleared after a few rounds with shell, leaving her a mere wreck. I think therefore that this serious disadvantage should be well weighed, for England's cruizers should be ready to fight any foes they might chance to meet. Much difficulty is necessarily experienced by our constructors in trying to keep in advance of the times, and to make their ships so perfect as to meet every possible requirement of present or of future warfare.

What at present is required for naval warfare is an important problem. Commencing with weapons of offence, we doubtless want the ram, the torpedo, and the guns. Every cruizer should, as Captain Noel proposes, be a ram, and should carry torpedoes; then as to guns, it is of no use to provide her with guns that won't penetrate anything and everything she is likely to engage in distant seas; and therefore I take as the smallest gun which would be really effective against the present thicknesses of armour to be a gun of 18 tons.

The "Nelson" and "Northampton" are to mount four unprotected 12-ton guns and 2 protected 18-ton guns on each broadside. I think if the armour had been shortened they might have carried, in lieu of the four unprotected 12-ton guns, two protected 18-ton guns, and then if wished they could have also mounted two more 18-ton guns outside the shelter of the armour. To give a better idea of what I think a cruizer's armament should be, I will take one of the existing types, viz., the "Raleigh," a vessel of about the right size for a cruizer, but which is now armed with *shell* guns on the broadside, without a single plate-piercing gun amongst them. These weapons consist of 64-pounders, and what were efficient 6½-ton guns, but are now turned down to 4½-tons. The "Raleigh" has also one 12-ton revolving gun forward, and one 12-ton revolving gun aft. The weight of her guns is, I believe, 181 tons, and of her powder and shot, 255 tons, giving a total of 436 tons. Now the "Raleigh" could have mounted two 18-ton revolving guns on the upper deck, one forward and one aft, and used the same small rear turn-tables as those by which her two present 12-ton guns are worked. She could have had two 18-ton guns upon each broadside worked rapidly by means of similar small turntables, and have also carried a useful proportion of lighter guns. I hold that no ship should be armed with only heavy ordnance, for without a proportion of light and quick working guns she is liable to be destroyed by the attack of torpedo boats. The "Raleigh" could have mounted, in addition to six 18-ton guns, four powerful 64-pounder breech-loading guns—firing large charges of powder with steel shell (which would pierce ordinary armour), and also with the destructive double shell. In addition to these guns, she could have mounted four breech-loading anti-torpedo 20-pounders (giving very great elevation and depression), which would altogether make about 180 tons, instead of the 181 tons of her present guns. The supply of powder and projectiles would weigh about 218 tons, giving a total of 398 tons, so that the "Raleigh" could have been locally strengthened, and been then given a most powerful armament well adapted for all the purposes of warfare, in lieu of the inefficient armament she now carries, and without any increase of weight.

I think it is a great mistake to say, as some have recently done, that effective fire can only be delivered on the broadside.[1] A war vessel should be prepared to fight an enemy ahead, or to fight an enemy astern; in fact, the man-of-war should be prepared to fight at any and at all points; and she should be so armed as in any position to be able to bring the greater number of her guns to bear in every direction. Take the "Raleigh" as I have proposed, she should be armed as an example of what might be done; she would have been able to fire three of the six 18-ton guns from ahead to 15° abaft the beam, and the other three from astern to 15° before the beam, the bow guns and the stern guns crossing each other's fire.

[1] The service ogival-headed projectiles will not bite in armour beyond about 33° from the perpendicular: flat-headed projectiles will bite at nearly double that angle. The former being of cast-iron, are liable to break up; the latter being of steel are much tougher.—R. A. E. S.

On the broadside she could have discharged four 18-ton guns—the two broadside guns commanding a range from across the bow and stern respectively to 75° training in the opposite direction, or a total range of 167° for each gun; so that, excluding the lighter guns, which have wide arcs of training, the "Raleigh" would have been able to fire a broadside from four 18-ton guns, at any enemy, from 15° before to 15° abaft the beam; and to fire three 18-ton guns in any other direction, either ahead or astern. I think, however, that our future cruizers of the "Raleigh" class —but with more beam and a flatter floor, must be armour-plated. A proposal was made by an admiral to put on an inch of plating, but an inch of plating would be useless; it might break up our own weak cast-iron shell, but it would not break up the steel shell that Brazil and other naval powers are giving their vessels. I think there is no doubt but that all projectiles used in naval warfare will hereafter be steel *shell*, whether intended to be fired against armour-plated ships or for any other service, because such projectiles would be efficient under all the conditions of warfare.

The "Northampton" and "Nelson," with their rudders well under water, and their many water-tight compartments, have great advantages as cruizers; they have also two inches of iron deck to protect their boilers, and likewise traverses on the gun-deck to separate the guns. These ought always to be shut off one from the other, so that a shell bursting over one gun would not thereby disable the adjoining gun. There is a further consideration, namely, that when you come to armour-plate cruizers, whether such vessels will be able to move quickly and to tack under canvas. My own belief is that they will not; and I look forward to the time when the present heavy masts and sails will be done away with.[1]

The weight of the "Nelson" and "Northampton's" three masts, gear, and sails will probably be between 200 and 300 tons; take these away and throw their weight into coals, and see what an advantage you would gain. You would remove the top hamper, and give far greater speed going head to wind.

It would be a most interesting experiment to take a ship of the "Audacious" class, with a single lifting screw and sail power, and to keep her out for a certain time, trying her in every possible way against another vessel of the same class, but fitted with double screws, and having her masts taken away, and their weight added in coals.

The mistake often made is to suppose that cruizers are constantly to be steaming at great speed, whereas the fact is that these watchers over our commerce in time of war would usually be going at a very slow speed, and burning very little coal. If sailing power be dispensed with, the important question of coaling at sea becomes prominent. I believe it could be done, but numerous coaling stations and other needful arrangements should be at once prepared, and not left until we come to actual warfare.

I will now leave the question as to the best description of cruizer, for I think I have shown that the future British cruizer should be an ironclad, in fact, all our future powerful foreign service-vessels should, in my opinion, be armour-plated; and I think if we were to thoroughly re-arrange the armaments of our present ironclads, and to utilise them as cruizers, we should have a very formidable navy for ocean warfare.

Lately one of the "Minotaur" class had her main deck broadside ports enlarged at great expense merely to put 12-ton guns in them. For the same cost four 38-ton guns could have been mounted upon her *upper* deck, and thus have made her an efficient war vessel.

Here is a large ironclad that cannot turn quickly, and therefore the very vessel that ought not to be re-armed merely for broadside fighting; and yet the ports of this vessel were enlarged to mount comparatively inefficient guns, which can only be trained to fire on the broadside, instead of putting very much more powerful guns upon the upper deck, where they (the 38-ton guns) could have been mounted so as to have commanded the whole circle of the horizon.

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[1] Short masts to carry trysails to steady the ships in a gale, and to give a better draught to the engines in warm weather, and also to carry square sails when running free, are desirable.—R. A. E. S.

I do not, however, mean to compare this vessel with our modern ironclads, but I am showing how ships of this type could be rendered efficient.

During the time I was at the Admiralty, these matters were continually debated; and Sir Spencer Robinson and the Constructors, who always supported a policy of progress, and pushed forward the development of our armaments, know the very great difficulties that there are in the way of carrying out all such improvements.

The only other vessels I wish to advert to are coast defence vessels.

I think it is the greatest possible mistake for England to possess ironclads that are not sea-going. I know the contrary has been and is still insisted upon, and that small ironclads have been consequently built for coast defence.[1] I believe that what we want for coast defence are vessels of as shallow a draught as possible; and experience has shown us that we should build our vessels with a flatter floor and greater beam, which would give more floating power with little loss of speed.

General Schomberg has said, and you will doubtless concur in his view, that our gunboats should be vessels capable of mounting 35 or 38-ton guns, and be able to go anywhere round our coasts in order to assemble at any required point.

I would supplement these powerful gunboats by taking the river and coasting steamers and making them torpedo vessels.

Then in time of war, look what a numerous musquito fleet you would have, and how valuable such a fast fleet would be! Enter their captains and crews now as Reserve Seamen, and do not waste the present time in inaction, but use it in judicious preparation. Instead of keeping the captains of merchant steamers in the grade of Lieutenants of Reserve, let them rise to be Captains of our Reserve forces.

I must not here refer at length to the merchant seamen who form so important an element of our maritime strength. We have recently had discussions in this theatre as to maintaining a sufficient supply of British seamen, but it seems to me that in the plans of taking seamen from the mercantile marine in war time to supply the Navy, and in the other proposals made, we are merely groping on the threshold of the matter, at which lies the root of England's maritime strength. To maintain this intact, we must first of all have a very large Reserve; at the present time we have none, and there are no arrangements yet made as to how to man and to maintain the large force of drilled men which will be required for our ships during war.

Until these arrangements are laid down we cannot proceed satisfactorily in ship-building; for different guns and simpler means for working them will be required with unskilled seamen. With such crews we certainly could not attain to those results which England must achieve if she wants to keep at the head of nations, and to maintain intact her maritime superiority, and with it her enormous commercial wealth.

Captain J. C. Wilson, R.N.: It was not my intention originally to have spoken on this subject at all, but during the last discussion it struck me that the set of criticism was rather going against the gallant young officer who wrote this very excellent Essay, and who has received from this Institution its Gold Medal. I am one of those who think that his essay is excellent in itself, that the principles he has laid down are clear and distinct, and that whatever its merits or demerits may be, he has chalked out for us what was in itself a very difficult thing to do; he has tracked out for us a line where there was no track before, and one which we can now follow. I think anyone who writes on this subject hereafter, may possibly improve upon the essay, because they will have something to guide them, but we must remember when Captain Noel wrote this Essay, he had nothing whatever to guide him, he had to chalk out his own line, and I think he has done so very ably. We must remember that this subject is not dealing with the type of ships that we have in the Navy at the present time, not with what we are to do with the ships that we have, but the question is the "best type of war vessels for the British Navy," and I think I may add without being wrong, "for the future," not for the past. Now, the most telling criticism on this paper has undoubtedly been that of Sir Spencer Robinson. Sir Spencer Robinson, we all know, is on this question perhaps not only the first

[1] These might be converted into sea-keeping ships at small expense.—R. A. E. S.

man in England, but the first man in the world, and therefore I think it says a great deal for Captain Noel's paper, that it should have drawn such a very valuable critic as the late Controller: but I think Sir Spencer Robinson's criticisms are more confined to a defence of the ships which he had himself something to do with designing, than to the suggestions which are brought forward by Captain Noel. Sir Spencer Robinson evidently was much offended because this young officer spoke of certain types of ships now in the Navy as being "failures."

Sir SPENCER ROBINSON: Upon my word and honour, that is the last and most impossible thing that could have crossed my mind, to take offence at anything that is written there.

Captain WILSON: If I have said anything that is too strong, I regret it; what I mean to say, you criticized very strongly the statement that these ships were "failures"; indeed I think you had very good reason, because I do not think the bulk of officers of the Navy would venture to call such magnificent ships as we now have in the fleet, "failures."

Sir SPENCER ROBINSON: I found that in the pamphlet.

Captain WILSON: Will you allow me to correct you. I think you have made a slight error. You gave us to understand that Captain Noel condemned, not only vessels of the "Audacious" class, but the "Sultan" and other vessels of her class, which he does not do, with all due deference to you. He says:—"The second class "represented in the above mentioned article, includes the 'Audacious,' and her five "sister ships, and the 'Monarch' as a sea-going turret-ship. The first six of those, "though powerful vessels, are generally considered failures." That is to say, the first six ships, meaning the ships of the "Audacious" type. I do not think the bulk of my brother officers would venture to call even these ships failures; but Sir Spencer Robinson told us here that a mistake had been made in these vessels—he called it a slight mistake. The slight mistake of course is gaged exactly by the amount of iron concrete ballast which had been put into their double bottoms, and the amount of sail-power which had to be reduced, and that there is still a tendency to reduce the sail-power in these ships, and other ships, of a superior type, we see from time to time; only two days ago I observed in the *Times* that the "Sultan" was to have her mizen-mast taken out of her, the upper spars reduced, and to be rigged as a barque; I think that shews conclusively there was a *mistake*, and although Captain Noel had hardly reason for his statement that they were "*failures*," still there was at least a slight mistake in them; they did not come up to the standard which they were intended to reach when designed. I wish to say, I, for one, entirely approve of the great principle which underlies the whole of this Essay. That principle is this, and it was very ably put by my friend General Schomberg, the vitals of a ship ought to be protected as much as possible, and that it is a secondary consideration altogether whether the battery is covered or not; that after the vitals of the ship, the water-line, the magazines, the engines and the steering gear have been thoroughly protected, the next consideration is the amount of gun-power you are to carry on your decks, and in that I quite agree. I would rather go into action with another ship, ton for ton the same size as my own, my ship made as far as possible unsinkable, but with extra guns on my decks rather than have the weight in comparatively thin plates on my sides. Such is my view of the question, and I think Captain Noel is right in the great principle which underlies the whole of his Essay. I think his proposed ship fails in matters of detail. I do not think his details are as good as they might be. I quite agree with Mr. Barnaby, and believe that he is right, and that Captain Noel's calculations are wrong. I also go with Mr. Barnaby in preferring his ship, the "Northampton," or the "Nelson," to the ship proposed by Captain Noel; but the principle is the same in both cases. I do not think Captain Noel claims any originality of design. The object of the Essay was not originality particularly, but to write the best Essay upon the style of ships that were thought best, and I think he has done good service in drawing attention to the advantages of these ships. Sir Spencer Robinson in vindicating his own style of ships, what we may call the "covered battery ships," described a very harrowing scene as likely to occur when the uncovered battery ship went into action and received a broadside from an enemy with a covered battery at 1,200 yards,—how the main-deck would become a shambles, how the guns would be dismounted, and the

ship have to run away. We all know the inaccuracy of fire at sea, and we also know that not 50 per cent. of the shot fired from a ship, even in fine weather, would strike at 1,200 yards. Now take into consideration that the men who are firing the guns have nerves, in addition, the motion of the ship, and I do not think there is any great chance of more than 25 per cent., that is to say, one out of four or five shots striking the ship at all, and as to striking the battery it is a great chance if any does. Therefore, I think the damage anticipated in that way was much exaggerated. Now I take the case of the uncovered-battery ship. She has passed inside this magic circle—she has run through the 1,200 yards, has got inside of a 1,000, and opened fire upon her enemy with a covered battery, the ship with the uncovered battery carrying at least two or four guns more than the one with the covered battery. I say, whenever she gets within the magic circle, the number of her guns will tell, and not only will they tell, but they will tell most destructively against the thin armour which covers the battery of her opponent, and in less than half an hour she will knock her into a cocked-hat. As to the cruizers I again think Captain Noel is right. I will not enter into the details. The details in these questions are matters for the naval architects; but I think the principle is correct—protect the vitals of the ship, give her as much gun-power as you can, as much sail-power as you can, and then you have a good cruizing ship. I disagree with Captain Scott about the weight of metal she should carry. I do not think it is a good thing to have no large guns; I think he puts the size of his large guns too high; but I speak with all due deference to him. I would rather have more 12-ton, or even smaller guns, than have a very few 18-ton guns. I prefer number to calibre if of sufficient power. I also disagree with him in that he prefers a ship being mastless. Where are you going to get your coals? Where are your coal depôts? When your coal is consumed, how are you going to replenish? Why, it would take half the Fleet to convoy your colliers alone. No, you must be dependent upon something which will never be used up, you must be dependent upon your sail-power. Now we go on to the "Devastation" class, and here also I would like to say one word. Captain Noel says he does not like the "Devastation" class of vessel, but he also raises certain objections to them. Sir Spencer Robinson, however, gave us a very interesting little nursery rhyme the other day about "the reason why I cannot tell, and Dr. Fell," &c., but I might also quote very much the same sort of thing about "doctors differing," &c., I think we certainly see there is a good deal of difference of opinion between Sir Spencer Robinson and Mr. Barnaby, on this very question of covered and uncovered batteries.

Sir Spencer Robinson: I beg leave to say you must have misunderstood me. I have no difference of opinion whatever. On the opinion expressed by Mr. Barnaby as to the uncovered battery of that ship, the "Northampton," I agree with him entirely.

Captain Wilson: I was certainly under the impression that you were not quite unanimous in your opinions.

Sir Spencer Robinson: Perhaps, if you will allow me to say so, I think the way you have fallen into your mistake is this. I do not think the "Northampton" is to be classed as an ironclad fighting ship, but as a belted cruizer she is exactly the class of ship that I think ought to exist.

Admiral Houston Stewart: The "Nelson" and "Northampton" were not designed as line-of-battle ships; exactly the contrary, and they appear in the Parliamentary programme as protected cruizers. It was never intended that they should appear in the line-of-battle in any way.

Captain Wilson: I am speaking of them as recommended by Captain Noel. I only referred to the "Northampton" class as ships I prefer to those he suggested. With regard to vessels of the "Devastation" class, I think they are very formidable ships, but I do not think when the question was brought up here, and they were referred to by the Constructor of the Navy, that he explained away the objections which Captain Noel advanced to the "Devastation." If his objections are explained away, I think there can be little said which is not in favour of such ships for special purposes. The only thing I have not touched on now are the coast defence vessels. There, I think, in principle, he is again right, though his details may be wrong. Mr. Barnaby very clearly showed us the other day, that circular ships of

the dimensions proposed would be too expensive, and his argument that you could get a very large number of gunboats for the same money was conclusive against them, still I think there are circumstances in which such circular vessels would be useful and even necessary, such as at the mouth of the Thames, the Mersey, and other places, where they would be infinitely preferable to stationary forts. For coast defence generally, I do not think they would be so good as thoroughly efficient gunboats. I will conclude by observing that I consider this Institution is really very much indebted to Captain Noel for his Essay, which I think is worthy of him; still I hope he may yet, after this discussion and the hints which he may gain from it, look over his paper and re-write it for our general benefit, and thus produce something even better than the original for which the Gold Medal was awarded.

Captain BEDFORD PIM, R.N., M.P.: When the meeting was adjourned last Monday, I thought it my duty to give notice that I should move on this occasion, a certain resolution to the effect "that this meeting is of opinion that the Essay of Commander "Gerard H. U. Noel, R.N., for which the medal of this Institution has been awarded "this year (1876) bears the impress of hasty and ill-considered compilation, and does "not point out the best type of war-vessel for the British Navy, 1st, for combined "action; 2nd, for single cruizers of great speed; 3rd, for coast defence." At the time I gave notice I was not aware that Captain Noel was out of the country, and to press such a resolution would be extremely ungenerous in his absence. I simply wish to make the explanation why I do not now bring forward my motion.

Captain WILSON: It would not have been allowed even if Captain Noel had been present.

The CHAIRMAN: Captain Pim did not hear the observations I made at the commencement of the meeting as he was not then present, therefore, he is not aware that we are not here in a position to pass resolutions. We are simply here to discuss certain naval or military questions which are brought before us, and it would be positively illegal to move or carry a resolution.

Captain PIM: I suppose it is quite competent for me to say, as a life member in this society, that I entirely demur to the ruling of the Chairman.

General Sir WILLIAM CODRINGTON: I think I may rise to a question of order: it is not only the ruling of the Chairman, it is the ruling of the Council.

Captain PIM: I am a life member of the Institution and flatter myself I know something about the rules and regulations, and still, although it may be the ruling of the Council, I feel exactly the same, because we are met here on this occasion to discuss an Essay upon a subject, which, as I consider, is of vital importance to this country. I look upon this Institution as the first of its sort in the whole world, and this Prize Essay will go out to the whole world and it will be taken in all parts of the world as the opinion of the finest—I hope I may say—sailors in the world. Under these circumstances, when we come here to discuss it, surely a Naval Officer may express an opinion, and, consequently, move a resolution. I know I heard opinions expressed very strongly indeed, by a naval architect against Captain Noel, in this room last meeting—very strong opinions indeed were expressed. I am sorry to say, in my opinion, the gallant Officer who has written this Essay, has entirely failed in carrying out the object which this Institution had in offering a prize. He starts by telling us "Reviewing our present Navy, we cannot but feel proud of its great "strength and of its undoubted superiority over that of any nation, or even of any "other two nations. Our ships are not only numerous, but well-built, powerfully "armed, and admirably equipped." I beg to join issue at once with the gallant author of this paper. I feel very strongly indeed, that our ships are not only not numerous, not only not well built, not only not powerfully armed, but they are not admirably equipped. I must confess I look with the greatest possible fear and dread upon the state and condition of our Navy at the present moment. I am not going to place merely my own opinions before this meeting of brother Officers, but I will prove my position by the opinions of the best Officers that ever trod upon a plank or sailed under a pennant. Captain Noel tells us that the "Hercules" and "Sultan" have been thoroughly tested and found efficient as sea-going ships. He also tells us that the "Audacious," and her five sister ships, I suppose he means her *four* sister ships—perhaps he did not remember that the "Vanguard" had sunk—and the "Monarch" are now efficient ships of war, but not of

a type likely to be increased in number; and in his third class he says the "Bellerophon" is a type of that class, and that she is a sea-going ship of deserved repute. Now, what do we find given in evidence before the Committee of Designs, by, as I said just now, some of the first Officers of this country, prime seamen, and as good officers as ever stood upon a plank? I will not, for a moment, venture to give my own opinion on the matter, but I will take, in the first instance, the present Controller of the Navy, Admiral Stuart. I have had the honour of knowing Admiral Stuart for some years, and I do not think you will find his superior, as a sailor, in Her Majesty's Navy. He says:—

"Question 4142. Mr. Reed designed the 'Monarch,' 'Hercules,' 'Bellerophon,' and 'Audacious' class to sail as well as sailing ships, and I expected that the 'Monarch' and 'Hercules' would sail well; but they do not do so, nor do the 'Audacious' and 'Vanguard.'"

Again, what does Admiral Sir Thomas Symonds say—I suppose he is an undoubted authority with every one present in this theatre and in the whole of England I should imagine—he says:—

"Question 1064. When the 'Hercules' pitches you will see her spur right out of the water, and it is the same with any one of them. They jump out of the water in a way that you would hardly believe possible. I have known the 'Hercules' when the Channel Fleet was exercising steam tactics, report, in answer to signal, February 5, 1870, off Lisbon, a roll of 27° to starboard, and 25° to port. Where would be the water-line heavy armour plating?"

"Question 1084. I have seen the 'Hercules' running with everything furled upon the mizenmast, and chiefly upon the mainmast with her sail all forward, broach to, carry away the wheel ropes, and become perfectly unmanageable without steam, and with a nice steady breeze running before the wind at 10 knots."

With regard to the "Audacious" class, the scientific principles upon which they were built, that of throwing the centre of gravity up high, is one of the most astounding I have ever heard of in my experience at sea, and I am quite certain the Honourable Member for Derby would be horrified at the idea, that because you put on a heavy deck-load, so long as you make that deck-load sufficiently cumbersome, the ship becomes more seaworthy—but, however, that was the scientific principle upon which the "Invincible" class was built. This is the report at a trial trip of the "Invincible," in October, 1870, of which I will read the account to the meeting:—

"The 'Invincible,' Captain Lambert, in charge of Captain C. Fellowes and staff of the Steam Reserve, left Plymouth Sound for the six hours' official steam trial. At the time of the 'Invincible's' leaving the Sound, she was at a draught of 21 feet 8 inches aft, and 20 feet 6 inches forward, her double bottom not being filled with water, and having no ammunition on board, the object of this trial being to test her new screws at a six hours' run of uninterrupted steaming. At starting the weather was quite calm, but prior to her return a strong breeze set in from the westward with proportionate sea. The ship during the trial was kept with the wind abeam, and when she first hove in sight on her return, steaming in from the southward, she had the appearance of being almost on her beam ends; and as she approached the Sound it became evident that she was heeling over 17° to 18°, and the greatest anxiety prevailed on shore for the safety of the ship. Although the 'Invincible' heeled to this extent, she had not a stitch of canvas set, and her topgallant masts were on deck."

And in evidence what is said in answer to—

"Question 3713. Lord Dufferin (Chairman). I never heard any captain condemn his ship more completely than Captain Lambert did, and I have never read a report so fatal to a ship as the report of Captain Fellowes, especially as the captain of a ship generally (perhaps in a praiseworthy manner on the part of the Officer) sounds the praises of his own ship."

As ships they are nearly useless and as fighting machines worse than worthless, as shown in the evidence of Mr. Wm. Pearse, of the firm of John Elder & Co. He says in reply to—

"Question 2079. The bottom is generally weak and should be strengthened.

"Question 2080. In fitting the machinery, if we had any doubt of the vessel

"grounding, we boomed the vessel off from the quay into mid-stream to prevent it, "knowing that if she touched the bottom even with the water only leaving her "10 inches, something would break, either a frame or a bracket plate."

"Question 2085. The 'Audacious' is very weak, so far as her defensive power "is concerned. In the first place, the main deck forward and aft of the battery is "only about 4 feet above the water line. This deck is of 3½-inch fir, and $\frac{3}{16}$th-"inch steel plates, the top side above the main deck is of $\frac{3}{8}$th-inch steel plating; "this is the *only* protection to prevent a shell going below the main deck to the "boilers and engines—it would get to the boilers and engines, and also, in my "opinion, get to the magazine, seeing that the magazine bulkheads are only of "¼-inch plating, with two thicknesses of inch teak.

"There are four large ports in the battery having an area of 15 square feet each. "I think rather than make a pretence of protecting guns in that way, that it would 'be better to give them no protection at all."

"Question 2215. When I said that one of these ships would not stand that "(bumping), I was speaking of circumstances under which an ordinary merchant "vessel heavily loaded would stand such bumping."

"Question 2232. Under circumstances in which the 'Audacious' would in-"evitably be destroyed, an iron merchant ship might not be damaged."

The other ships now left to us are the "Audacious," the "Triumph," the "Swiftsure," and the "Iron Duke," and in my humble opinion they are all equally bad. I should say that more wretched ships it would be hard to find floating on the ocean. These ships have been heavily ballasted. I moved for a return in the House of Commons last year, and I find that has been the case with a great number of Her Majesty's ships. I heard Sir Spencer Robinson say at the last meeting, what, of course, we all know perfectly well, that in olden days ships had a certain establishment of ballast. Of course they had; they were sailing ships; it was necessary to put ballast into those ships, because they had their centre of gravity thrown up high by their batteries; but I must confess I never heard of putting ballast in a steamer; I can hardly conceive such a thing possible as a man sitting down in his office and designing a ship with tremendous boilers and engines, and no end of coal on board, and then sending her out to sea and finding that on her trial-trip she heels over 17° or 18° under bare poles, quietly saying that there was some slight mistake and then having to put 600 tons of ballast on board that ship.

Sir Spencer Robinson: I beg your pardon. The "Sultan" has only 460 tons by your own returns.

Captain Pim: 400 tons of scrap iron and cement. You are quite right. I beg your pardon. But even if she had 400, or even 4 tons of ballast on board, it would be equally disgraceful to those who designed her. Now, with regard to the "Bellerophon," this vessel was pronounced to be the very acme of naval science. There was no impediment thrown in the way, and she was to be a most perfect ship. What do we find in the evidence before the Committee on Designs? Mr. Reed said, "I freely stake my reputation on the fact that the 'Bellerophon' cannot fail "to steam over 14 knots." Admiral Yelverton reports (Channel Fleet, 1866), "I "think the 'Bellerophon' ranks below the 'Lord Clyde,' and on a par with the "'Ocean' and 'Caledonia.' In this respect I was disappointed, for I expected "much greater speed. In steaming full speed, the 'Bellerophon,' 'Ocean,' and "'Caledonia' were nearly alike."

Everyone knows that the "Caledonia" and "Ocean" are wooden line-of-battle ships, converted into ironclads to meet an emergency, and their full speed at sea was 11 knots.

Then Admiral Warden (in 1868) shows that the old ironclad "Achilles," of the "Warrior" class, averaged a speed of a little under 13 knots, while the "Beller-"ophon" could only do a fraction over 11 knots an hour. But the most con-vincing testimony to the inefficiency of the "Bellerophon" was given before the Admiralty Court, in the case of the steamship "Flamsteed" *versus* Her Majesty's ship "Bellerophon," Captain Richard Wells, of Her Majesty's ship "Bellerophon" stating, that this ship "lay like a log upon the water when hove to; that, if there "was plenty of wind and the sea suited her, she could be kept on her course; but "it was difficult to keep her off the wind, if the sea did not suit her; her after

"sails were of no use in keeping her to the wind; but, on the contrary, had to be "set to wear the ship;" [a startling novelty] "under sail alone she was unmanage- "able," and "more unmanageable in strong than light winds."

The "Bellerophon" was designed to compete with the "Warrior," and entirely to distance her in every respect. "The 'Warrior' was first, and the 'Bellerophon' "last," and further on Admiral Warden says, "Here again we have the 'Achilles,' "one of the first ironclads built, distancing, in a run of 100 miles, occupying eight "hours, some of the latest constructed ships, containing generally the most recent "improvements, condenser, &c., in a very remarkable manner. . . . . It is to "be borne in mind that, while the engines of the 'Achilles' develop 5,700 horse- "power, to drive 6,000 tons, those of the 'Bellerophon,' 'Lord Warden,' and "'Lord Clyde,' develop about 6,000, to drive 4,000 tons. It is a result, I think, "calculated to give rise to very serious reflections."

The CHAIRMAN: May I ask you to keep as closely as you can to the subject of our discussion, which is the Prize Essay, and not the conduct—present, future, or past—of the Board of Admiralty?

Captain PIM: If it is not the wish of the meeting that there should be free discussion on this matter, I really must decline to go on. Sir Spencer Robinson had an hour and a-half, in which he showed the admirable qualities of his own ships.

The CHAIRMAN: He very properly criticised the remarks of the Prize Essay, and did so without one word that would, in any way, hurt anybody else. We want freely to discuss the Essay, and all the points bearing upon it; but we do not want to go into all the details that are not mentioned in it; and we do not want one word said which could give anybody pain.

Captain PIM: I am sure anyone who knows me would be perfectly certain that I have no wish to hurt the feelings of anybody. I consider it most painful, but, at the same time, it is a duty that I have to perform, to show this meeting that we have about as unreliable a Fleet at this moment as it is possible to have. And you must bear in mind, I am not saying this for the first time, as something new; it was amply discussed in the House of Commons. I wish to show this meeting that we have about as unreliable a Fleet as it is possible for any nation to have. I am simply enlarging upon a sentence in this Essay, upon which the Essayist's conclusions are based; and I take it I have a perfect right to do so; but, if I am not allowed to give free expression of my views, as an English sailor, all I have to say is, if there is any responsibility in the matter, you may take it, for I certainly decline to go on.

Admiral STUART: I would ask your permission, as a gallant and distinguished member of the Legislature has paid me such a high compliment, and one which I do not deserve, by acknowledging me as an excellent judge of the qualities of seamen, to explain, with reference to the part of my evidence before the Committee of Designs, which Captain Pim has selected with reference to sailing armourclad ships, that the question I was asked was, whether I thought ironclad ships could be designed to sail well, and that part of my answer on the subject, is picked out. I merely said that it would appear by the past history of ironclads, in our own Navy and others, that they could not be designed to sail well, but that did not in any way trench upon their qualities as ironclads; it was simply as to whether I thought an ironclad could be designed to sail as well as ordinary ships; and I think, in the same evidence, Mr. Reed gave a very clear explanation of why it was found necessary to put ballast into these ships, and in that evidence he stated, in designing the ships, he always contemplated to develop the extraordinary qualities of steadiness which he wished to arrive at in ships of an entirely new type or design, that it might be necessary to place some ballast. I do not enter into the question of the value of that answer, but I think, if certain evidence given before the Committee is quoted, it would be much fairer to give the whole of the answers that bear upon the question.

Major MONCRIEFF, F.R.S.: Sir Henry Codrington and Gentlemen, I have very few remarks to make, and I shall endeavour to restrict what I say to the subject under discussion, especially to that part of it with which I am most familiar. Both the author of the Essay and its critics agree, and all that has been advanced leads to the conclusion that it will be a very difficult task indeed to meet, in the designs

of war-ships, the new requirements which recent improvements in artillery have rendered necessary; while, unfortunately, it has also been demonstrated that the necessity for meeting them is much greater than it was, and becomes more and more pressing with each improvement in artillery. I do not intend to offer any opinion as to the types of vessels which have been recommended, or to criticise those existing; but I should wish to remind the meeting that on all hands it has been agreed that the defensive power of an armoured vessel, or, in other words, her armour, must now be confined almost entirely to her vitals—unless that armour is made thinner and lighter than what is pronounced to be requisite. In these vessels (the "Nelson" and "Northampton") a most ingenious and, what appears to be an effective plan, explained by Mr. Barnaby, has been adopted for dispensing with armour in the bow and stern parts of the ship, but in the central part strong armour is placed, so as to protect the water-line and the machinery. Sir Spencer Robinson and the Chief Constructor explained that the armament of these vessels is, in fact, the men and the guns, which are also protected by armour, to a certain extent, but not so much as they could wish. The Prize Essayist, recognising the great sacrifice at which even this slight extra protection to the men is obtained, actually recommends, as a better alternative, that the armament and men should be left entirely unprotected, so as to obtain the maximum offensive power compatible with the safety of the ship. The discussion has brought out strong arguments in favour of this alternative.

In these circumstances, I submit that any other alternative that is reasonable and practicable, which would obviate that sacrifice on the one hand, or that exposure on the other, ought at present to have attentive consideration. I beg to say that such an alternative exists, viz., the disappearing, or Moncrieff principle, carried out by hydraulics. It has been submitted in more than one form. On the 1st of February, 1870, it received very favourable opinions from the Lords Commissioners of the Admiralty, but the proposal (which, I dare say, has not been considered in all its bearings) came from myself—while I was in the employment of the War Office, applying the disappearing principle to land service—and was therefore probably considered as a subject which should be first tested by the War Department, before any serious application of it was made by the Admiralty. Accordingly, this course was suggested to the War Office by the Admiralty at the time. At that date, viz., February, 1870, I had not a design for a land service carriage of this kind prepared, and I regret extremely, both on personal and national grounds, that the recommendation of the Admiralty did not lead to a trial with such heavy guns as are required on board ship. The War Office, notwithstanding my earnest solicitations at subsequent dates, still restrict the application of the disappearing principle to counterweight carriages, which are not applicable to the Navy, nor so good for heavy guns on land. The consequence is, that at the present moment we are discussing the armaments of vessels and their designs, and admitting great and inevitable difficulties, some of which might have been absent, had that principle been developed by practical trial. I confidently assert that such trials will at once remove all hesitation to use it in those ships for which it is adapted. I think most sailors allow at the present time, that the disappearing principle would be of the greatest use, if successfully applied. To explain my meaning take, for example, this vessel, which has a strong iron deck, 4 feet above the water-line, at the level of the top of the armour. It stands to reason if you can afford to have the ports 2 or 3 feet above the deck, that is 6 or 7 feet above the water-line, and if you can deliver fire through these ports as effectually as at present, which I guarantee to do, that a result of some importance is within reach. The guns can thus be loaded and worked underneath the armoured deck, where the men and the machinery are entirely protected by sufficient iron plating or by the water itself. You thereby at once get one advantage of Captain Noel's proposed vessel, viz., the absence of extra armour, while at the same time you escape from a disadvantage of this belted cruizer (the "Nelson"), which Captain Noel endeavours to avoid at the expense of great exposure. In other words, you obtain the means of carrying a much larger armament, without loading the vessel with high and extra armour, expressly to protect the men at the guns; while the protection you do obtain for them, around any of the guns thus mounted, is not of doubtful strength, but is complete, being the same

which is provided for the ship itself. As yet I have only been speaking of the application of this principle to broadside guns. That, however, is not the only, or, in my opinion, the best application of this principle. I think its best and most complete application is to deck guns, for all round fire. The guns in the barbette towers of the "Téméraire" are mounted on this principle; at any rate, I submitted designs, on the 30th September, 1873, at the request of the Admiralty, for that vessel, which I understand have been carried out by a great engineering firm, with some modifications. These guns, however, would have been mounted on this principle, to much greater advantage, could the towers have been dispensed with. They very much hamper the service of the gun, and thus cripple its efficiency. The barbette towers were decided on for the particular requirements of this vessel before the disappearing carriages for them were designed. When the armoured deck has sufficient height to dispense with such towers, great advantages can be obtained.

The ordinary revolving turret will, I presume, now weigh 350 tons. If so, four guns could be mounted, with all the advantages of lateral range and protection afforded by these turrets, with a saving of at least 580 tons top weight. Now, it has been explained to us what increase of armament can be substituted for 580 tons; seeing this, and seeing that the ordinary turret requires at least as high an armoured deck as is required for my principle, it surprises me, in view of the value of this large saving in weight, that no attempt has been made in England to apply that principle in its integrity—that is, in the manner it can be most advantageously used. At this critical and transition stage in naval design, I hope it may be recognized to be the interest of the State to develop the principle I advocate, along with other alternatives, so that it may be proved and ready for application by the naval architect, in any case in which he can use it with advantage and economy.

I should have offered some remarks upon the application of the "Moncrieff" principle to circular vessels, recommended by Captain Noel in the Prize Essay, but as this would lead me into details which, I think, are better avoided in this important discussion, I shall not further occupy your time.

Commander W. Dawson, R.N.: Mr. Chairman and Gentlemen, the Prize Essay which we have met together to deliberate upon, and which has met with the approval of three of our most eminent Admirals, has been spoken of by Sir Spencer Robinson in a way which shews that the essay is one of very considerable importance, otherwise it would not have received the marked attention which he has given it. In his remarks Sir Spencer spoke of the essay, as we should expect a person in his high position and of his great authority, with great dignity, forbearance, and judgment, and what he said received very great attention from us all. Nevertheless, I am placed rather in a difficulty in following Sir Spencer Robinson and commenting upon this essay in consequence of the impression which he conveyed, that any suggestion as to the improvement of former designs, or as to the adoption of new types of ships, was a reflection upon the designers of the older vessels. But if there be any truth in such an idea, then the persons who originated those everlasting improvements in our fleet, are the real authors of these reflections upon the older classes of ships; and as the same naval architects described both the older and the newer vessels, they have been denouncing themselves by these changes. Though it is many years since the "Vanguard" and her sisters were built, they have not been repeated. Many other descriptions of broadside ships, and many other types of vessels have been subsequently built not only under Sir Spencer Robinson's administration, but under the administration of the present Controller; and not many weeks ago we were engaged in this theatre in discussing an altogether novel class of ship, brought forward by whom? not by Captain Noel, not by any stranger or outsider, but by Mr. Reed himself. So that if proposing improvements in the ships previously built is to be looked upon as an attack on the architects who designed them, then it is those architects themselves who have attacked themselves. Let us rather cast aside all feeling of personality, for if personalities are to be brought into this discussion I should feel extremely awkward in discussing a scientific Essay. Captain Noel is not an architect, but as an Officer of common sense he has read the writings of eminent men, he has gone to the works of naval architects, and he has borrowed ideas from naval architects. The very ship he puts forward in this essay is practically to

all intents and purposes the ship brought forward in this Institution by Mr. Barnaby, and discussed by us some three or four years ago. Captain Noel has had the temerity to offer a few suggestions for altering some of the details of the "Nelson," and those alterations, it is agreed on all hands, are not improvements, but substantially the principle which Captain Noel goes upon is the principle recommended in this Institution by Mr. Barnaby three years ago, and now embodied in the "Nelson." What was that principle? Simply this, that it was far more important for the purposes of her own defence that the ship should be able to throw a heavy fire than that her topsides should be able to resist a heavy fire. Mr. Barnaby asked, three years ago, "Are you prepared to throw off so many hundred tons of armour in order that you "may obtain so many hundred tons extra of armament?" and the general reply was, "Yes, give us plenty of big guns that we may hit many heavy blows." What has been the rule with reference to armament? Why in all the later ironclads there has been a continual diminution in the offensive power of the armament. We have an instance in the "Devastation," a ship of 9,000 tons, carrying only 140 tons of ordnance. That is a very limited offensive power for any first-class ironclad. A vessel of 9,000 tons displacement required to carry 140 tons of ordnance, and that 140 tons is necessarily divided into only four untried pieces. If anything happens to one of these four untried pieces, one-fourth of the armament will be lost. Besides that, the chances of hitting are very much smaller than Captain Wilson put it, for I believe that under the best circumstances of firing at a target it is somewhere about one hit in ten shots; and it would be much less in firing in a naval engagement. The general principle of heavy armament and unprotected batteries which Captain Noel advocates is really the same as that adopted in the "Nelson." It is quite a new idea which Sir Spencer Robinson has brought forward, and which I am sorry to hear supported by the present Controller, that a ship of this class is to run away from every hostile vessel that it meets on the high seas if that hostile ship has a strip of armour over her guns.

Sir SPENCER ROBINSON: I beg leave to state that is not my meaning.

Commander DAWSON: She is not to fight a vessel which has armour-protection to her guns?

Sir SPENCER ROBINSON: She will not fight on equal terms a vessel with armour protected guns. I said nothing about running away.

Commander DAWSON: There are only two ways of dealing with a hostile vessel at sea. You must either run away or fight. What is the principle kept in view in the construction of our ships? The principle laid down by Sir Spencer Robinson here. I should not take it up as a mere catch-word if it was not constantly dinned into our ears in the public press from time to time that a special ship is built to fight another special ship of the same class. That is quite an absurdity. A special ship is most unlikely ever to meet in hostile encounter a vessel of the same class. If there were an European war to-morrow, what are the chances that the "Nelson" would fight a vessel of her exact type? The chances are one hundred to one against it. Indeed, she could not find a foreign ship of the same type, because there is not another such ship in existence, so that she would not fight at all. Any British ship, large or small, armoured or unarmoured, driven into a corner—and remember British ships have not always got the best legs, and cannot always run away—should be able to avail herself of a certain amount of the chances of war, whatever the thickness of their respective hides, the British ships should have teeth wherewith to attack the enemy and give him a bite. But if you take away from British ships their armour-piercing guns, so that they cannot pierce hostile armour, if you do not arm them with projecting stems, if you do not provide them with torpedoes, then those unarmoured ships when attacked by a Japanese, a South American, or a Turkish ironclad, or by a weak ironclad of a stronger nation, have no chance for life. Such British ships must run, and when they cannot run, they must strike the British flag, simply because they have no teeth to bite with. The teeth (guns, prows, and torpedoes) put into them is regulated by the thickness of their own hides instead of by that of the hides of possible opponents.

The salient point which Captain Noel puts forward, has been very wisely fought shy of in this discussion, namely, the sinkability of ironclads. The "Vanguard,"

we are told, was built to fulfil a certain object; and we must not question her design, because she has fulfilled that object. What object has the "Vanguard" fulfilled? She is at the bottom of the Irish Sea. This is the vessel, the design of which Captain Noel (not knowing she was about to descend to the bottom of the Irish Sea) ventured to question. But the "Vanguard" is not the only ironclad by some half dozen that went to the bottom of the sea, without injury to their armour-plating. Other ironclads have had awkward premonitory abrasions of the skin tending towards "taking soundings." I am speaking in the presence of many naval men, who will remember various scratches which the skins of iron ships have had within the last fifteen years. Do not you remember how the "Defence," lying at Spithead, had a nasty scratch made in her skin by her own anchor? and how the "Warrior" had an awkward scratch made in her skin by some gunboat? The "Northumberland," too, had a nasty premonitory scratch. And do not you remember, Sir Henry (Codrington), when you commanded at Devonport, how one of your ironclads had a very awkward scratch? Who gave that invulnerable armoured ship that scratch? Not another ironclad. No; a small Irish passenger steamer. It was in smooth water, and at slow speed. I venture to say, that as Commander-in-Chief of that Fleet, Sir Henry Codrington must have had curious speculations as to what might have been, had that ironclad been in the open sea in rough water, and that Irish passenger steamer, going a little faster, had struck that armoured vessel a little harder. The consequence might have been that we should have had an ironclad at the bottom of the English Channel, as well as one at the bottom of the Irish Channel. What the Essayist has placed in the fore front of requirements is the unsinkability of ironclads. He has not given us a complete cure for it; but he has pointed out a very important defect, which ought to be considered, not only in the construction of ironclads, but also for the destruction of hostile ships in battle. If there is anything in this Essay about which I feel sore, it is, that the writer has unfortunately taken to pieces our own ships. I have long wished to see all foreign navies taken to pieces in this way; so that every English Officer, knowing where are the soft points in each foreign ironclad, might know what could be done for its destruction by his own vessel, however small, in case he were obliged to contend with a hostile vessel, however large. In this question of doing injury to the bottoms of ships, the small ship will have an advantage in the fight over the longer ship. I mean that an ordinary small, somewhat short and handy, unarmoured ship, may not altogether despair, if attacked by a vessel trusting in her armour alone. I do not mean a ram specially built for the purpose; but that those frigates, corvettes, and sloops-of-war, now traversing the seas, if properly armed at the stem, and protected by armour-piercing guns, would, if driven into a corner, have some chance in a fight with long armoured vessels, say like the "Northumberland." These unarmoured ships and thinner plated ironclads would have so fair a chance in the fight with thickly armoured long ships, that the Captain who attempted to haul down the British flag without trying the fortunes of war, would deserve to be hung, drawn, and quartered.

There is a chapter in this Essay, the heading of which I do seriously object to, and that is the chapter headed "Coast Defence Ships." But the existence of that chapter is not Captain Noel's fault. It was the fault of the Council of this Institution, with all due deference to you, Sir Henry, for giving him such a title to write upon. But having such a chapter given, I do not know that Captain Noel could have treated it better than he has done. I object to that term "coast defence ships." "Coast defence ships," as applied to the British Islands—what does it mean? It means this—sending a certain number of ships to blockade hostile ports in all weathers. That is England's coast defence; it is the only floating coast-defence England has ever had. There never has been a ship built in this country to this day—and this is an historical point—there never has been a ship built within the memory of any man living for the purpose of the coast defence of England. Certain ships were built for sea-going purposes, and those ships failed. I do not blame the naval architects who thus failed, because naval architecture is an inexact science, in which progress is made by guesswork. I have great respect for naval architects, but I do not look upon them as people who cannot make mistakes. These failures were designed by most able men, and science has learned

a great deal from these mistakes. So far from blaming those designers, I give them great credit for their courageous ventures; for if there had not been such bold ventures, England's Navy would never have been in the proud position it now occupies. Do not mistake me, then, when I reflect upon some of the ships of England. The war ships of England are the pride of England. The whole of Europe and the whole of America look to the constructive department of the English Admiralty for examples for the construction of ships of war. Therefore, it does not at all follow, because we point out the errors of the past, that we are at all blaming the courageous and talented administrators and designers who have fallen into those errors. For my part, I do not blame them at all. But what are these "coast defence ships?" Vessels built for sea-going purposes, and to blockade hostile ports. But they were found not to be sea-keeping, or not to be seaworthy. These unseaworthy or unseakeeping ships were therefore placed in the list of "ineffectives," but we do not manufacture "ineffectives" purposely, merely to put them on the "retired list." These so-called coast defence ships are simply "ineffectives" placed on the "retired list," some hidden away at Bermuda, others up the Tamar, and so on—"out of sight, out of mind"—with the hope that they will pass out of existence as quietly and as soon as possible, seeing that their maintenance on the retired list is an expense to the country. Moreover, I do object to unseaworthy vessels being called English "coast defence ships." A ship which can manage to weather a gale in the Atlantic might not be able to weather a gale on the coast of England. For this reason: a Captain of a ship in the middle of the Atlantic has only to think of the winds and the waves, and he manages the ship with respect to the winds and the waves; but a ship caught in Cardigan Bay, with rocks under her lee, cannot be navigated with reference to the winds or the waves; she must be navigated with reference to the rocks under her lee, and, consequently, the vessel is far more tried as to seaworthiness than she would be if in the middle of the Atlantic. A ship for the coast defence of England must be far more seaworthy than if she had to go abroad. Therefore, the greater number of vessels now classed as coast defence vessels are not properly so called, in consequence of some being unseaworthy. The others, which are unseakeeping, cannot be properly so classed, for they are not designed specially for shallow waters. None of them have the special requirements wanted in vessels designed for shoal water and stormy seas. The term "coast defence ships" might be correctly applied to circular vessels, because they are designed for shallow waters and for the special purposes of inland waters. In designing a circular vessel for the special purpose of defending the Thames or the Mersey, a real coast defence vessel might be obtained. I think I called the circular vessel for sea-going purposes a saucer-shaped diving-bell, but it might be made at least a floating structure which would float a battery in inland waters for special coast defence. What we want, however, is not a special class of vessel for inland waters, that is to cost £300,000 a-piece—it is not a single costly vessel of limited usefulness at the mouth of the Thames. What we want, is a multitude of sea-going and sea-keeping gun-vessels; the smaller the better; the heavier their guns the better; but they should be vessels which can go anywhere, and in any weather, and not be caught, as one of our so-called coast defence ships was, in going from Plymouth to Cork, when the barometer got too low, and the sea too high, and the Captain put back to Plymouth, reporting that it was a merciful interposition of Providence that this ironclad vessel got back to harbour at all. That would not happen to a broad-beamed seaworthy gunboat. Having very shallow draught of water, such vessels could go over the banks into shoal water, where they they could not be run down by deep draught ships which could not go there. Shoal water would, therefore, be a place of safety to vessels of this class. I will only, in conclusion, say, that so far from looking upon Sir Spencer Robinson's remarks as being in any way adverse to the ability with which this Prize Essay has been written by Captain Noel, I look upon Sir Spencer's remarks as the highest compliment which could have been paid to the judgment of the Referees in selecting this Essay. With all its faults of detail—and one can see at a glance that some of the figures are wrong—still, in its general principles, the Essay recommends itself to me as worthy of careful consideration; but I do not say necessarily that in every case Captain Noel's suggestions are worthy of adoption.

Admiral SELWYN: I wish to go a little more into the discussion of the paper, and less into the discussion of what has preceded the paper, than many other speakers have done. I think if Captain Noel's pamphlet had only been written to draw our attention to the fact that we have good reason to be dissatisfied with the resisting powers of our present armour, it would have had a very valuable effect. I wish to lay down as an axiom, and I think it will be generally adopted, what all our trials against armour have shown us, that wherever armour can be pierced by such guns as are ordinarily carried at sea, it ought not to be carried at all; that so far from being a defence to any battery which it surrounds, it is the very greatest danger, for the portions of the armour driven in by the shot, far exceed in number the splinters that would be made, and any damage that could be done, by shell. Therefore, when we draw attention to the necessity of armouring only in one part, and not in two or more widely separated places, making both by that process inefficient, the armour devoted to keeping the ship above water is decidedly the most important, since it is very little use to keep your battery intact if your ship won't stay afloat. But now that armour being incapable of resisting many of the modern guns, and the armour above being positively a danger, both are equally thrown away. He has brought forward, I think, a principle which ought to receive the closest consideration from the authorities—that it would be wise to limit the application of armour entirely to the protection of the ship's buoyancy, unless it can be given (which we have not as yet dreamt to be possible) in such measure as to entirely protect the battery, after the primary want has been satisfied. Major Moncrieff has brought forward a plan which I for one very highly appreciate: it is that of thickening the armour at the water line, possibly extending it both in height and depth, and fighting the guns below that armour and below water, bringing them up only to fire, letting them recoil under cover. With those conditions we can get as well a protected battery as a protected ship. But there is unfortunately another element of consideration, which is that the torpedo renders it impossible, where it is employed scientifically, ever to fight actions abeam at all, at least within its range. If a torpedo can be launched from the side of a vessel, and strike the bottom of her enemy lying abeam, I do not think there is at present any possibility of preventing the destruction which would ensue resulting in the sinking the vessel, unless by one or both of two methods. One is that cellular bottom which I have always advocated. This is said to be impracticable, because the engines must be all in one part, the coal-bunkers must be in one part, and the vessel cannot be cut up in sufficiently small portions on account of the large space occupied by the engines and boilers. The second method, which also commends itself very strongly to my appreciation, is the use of the turbine. The turbine-propeller can be separated into any number of small machines you please, and will be equally efficient with the largest propeller going. It is true the increased engine friction will come in to some extent and diminish its value, but it may be in the different compartments of the ship, and will draw out the water from any portion of that ship, whereas the screw must necessarily be applied at the end of the ship, and the friction lost by the long shafting will be probably found very nearly equal to that lost by the division of the turbine power. But there is this great advantage in the turbine, that the whole engine-power of the vessel in case of necessity can be devoted to pumping out that vessel as well as propelling. Therefore I say no future type of ship ought to be considered without reference to those points of cellular bottom and devoting the whole engine power to pumping out the vessel. I know engineers are not in favour of casting away a whole mould-loft of patterns, and until necessity arises they do not like to adopt new designs. If by these methods you can have a battery protected by the same armour which protects the ship; if you can have machinery which can propel the ship and pump her out; I think you will do unwisely to deny practically that Commander Noel has given you a useful basis of thought for the future. It is in that view I think the pamphlet is most valuable. As regards his proposals for a rudder, I think the time has not arrived when we can safely put a rudder where he proposes, or move it by the method he has shown, since the chain would be liable to damage, and the whole steering power would be gone. I will say further sail power is to my mind an absolute essential of all sea-keeping ships, and that sail power must be put into ships, not as we have hitherto put it in, apparently in utter carelessness of whether the ship will stay or

not, and with an unfortunate result that in most instances she won t stay at all. It is clear we must consider the placing of our masts more closely than we have hitherto done. Then comes the question of amount of sail, and whether an ironclad can be propelled at the same rate as any other vessel. I deny that there is anything in the shape, flotation, weights, or any other circumstance why the ironclad, with the magnificent models we see here constantly repeated, cannot be propelled by sail-power as fast as any vessel has ever been of that tonnage with proper sail-power. If you say the vessels are so built that they cannot by any possibility support sail-power, that their inclination will be too great under it to be safe, then I say that is a mere fault of construction, which I think any engineer would be ashamed to repeat twice. A person who puts ballast into a ship goes back to that time which we all recollect when our line-of-battle ships did carry about ballast with them, because their builders did not know how to thicken the bottom; and Sir William Symonds did away with it all by putting more oak into the bottom. The "Albion" and many other of his vessels went to sea without one ounce of ballast, and any engineer would have no difficulty in so disposing his weights as to keep an iron ship upright without resorting to brick and cement. The question as to stability is one which I must beg the members of this Institution to recollect in naval actions, as they will be at present fought, under steam, is very much less important than it used to be. If you prevent your ship from rolling, which you do by abandoning that extravagant idea of the steady platform which gunners have so much insisted on, and which yet has not enabled them to obtain a very great improvement in fire,—if you consent to come within a distance within which your shot won't miss, then I think you will find the stability, or rather the inclination the ship is likely to take during the action, is not such an element of importance as has been generally supposed; that is to say, we could carry our guns provided they be protected guns, as low as Major Moncrieff wishes them to be, without any danger of water entering the ports, and with sufficient command. The advantages gained are so very great over any system which puts the guns and the weights protecting them on the deck of the ship, that I do not think many men would choose the other alternative. As to vessels of the "Devastation" type, I think if designed as sea-going ships we ought to inquire very closely indeed what amount of coal they can really carry at full power. It has been said over and over again, if you consent to go at a certain speed you can go a great distance, but our enemies won't always consent to go at that speed, and if we cannot always equal them in steaming power without fear of expending all the coals on board we cannot call ours a sea-going vessel at all. We must either carry more fuel or carry condensed fuel. With regard to mastless ships, are they sea-going ships in any true sense of the term? Are they such ships as we could blockade a port with? My experience has been that it is almost impossible, what with fogs and steamers, to blockade any port effectually. I should like to see the time come back again when you knew where your enemy was going, when you had studied the wind and tide; but that is to-day impossible, and it is no use to talk about blockading a port unless you can do better than the Americans did at Charlestown; they could not do it—it was utterly impossible to prevent the blockade runners doing as they pleased. If you, however, rely on blockading ships you must have sea-going ships. Are you prepared to do that? Will a mastless vessel carry to sea sufficient coal to enable her to chase any vessel for a day or two, and come up with her if possible, and fight her, and then come back to her station perfectly prepared to perform her duties? If not, she is not a "sea-"keeping" ship. Circular ironclads have this to recommend them: that they are unmistakeably, as compared with all mastless ships of deep draught of water, of enormous advantage. It has been objected that they will not go as fast as ships of an ordinary type. If any gentleman consults Beaufoy's experiments, he will find that whereas the resistance of a square plate to forward progress at the rate of 8 knots is 224 lbs. per square foot, the resistance of a sphere of absolutely the same sectional area is only 64 lbs. Mr. Elder did not propose vessels as built in Russia, but the lower segments of large spheres of 16,000 tons capacity, and with fine water-lines, and the fair way is to compare them for speed when so built with their equals in tonnage. Their size has been objected to because they would not go into docks. What is the use of putting them into docks? They might go aground, have their repairs made, and go off again as soon as required. What they can do, is to carry to sea an enor-

mous amount of coal to go across the Atlantic and back at their full speed. What they can do, is to carry enormous gun-power: what they can do, is to carry unheard-of armour, and Major Moncrieff has shown how the guns can be placed below the decks altogether, can come up to fire, do their work, and disappear. I repeat the first consideration is the life of the ship—that is to be protected before and exclusive of the battery altogether, and I think naval architects must look to that. I have often heard my friend, Mr. Scott Russell ask naval men to express some opinion. He says, "If you only tell us what you want, we will do what you want." I think we do want that; and, secondly, that they should be sea-going ships, with such masts, sails, stores, and crew as may enable them to keep the sea when they are there.

Sir SPENCER ROBINSON: Would you allow me just two words of personal explanation. I observe two naval Officers, for whom I have the highest respect, have certainly misunderstood the object of what I said in respect to this Essay; both seem to think I have rather attacked Captain Noel, and that I have not felt, as they strongly feel, how extremely indebted we all are, every one in this meeting, every one in and out of the Service, to Captain Noel, for the pains he has taken in producing this Essay. Now, I am sure that I used the expression, as often as it occurred to me to refer to Captain Noel's work, "this very valuable Essay," and I spoke of him always as its "very talented author;" therefore, I think people who have censured me for the supposed attack I made upon Captain Noel have entirely misunderstood what I meant. I did not attack Captain Noel the least in the world, but I thought his principle, as to the war-ship required, wrong, and one which it was the bounden duty of any one who thought it wrong, to oppose. My idea being not that a ship should not be constructed on the principles laid down by Captain Noel for some particular service, but that for the particular service for which he suggests his type, namely, a first class ironclad ship-of-war, to fight another first class ironclad ship-of-war, it was, I thought, entirely unsuitable, and I said so; but my difference with Captain Noel was that and no other, and it was a very lawful and legitimate difference of opinion, strongly felt, founded on sufficient reason, and perfectly legitimate for me or any one else to hold and to express.

Mr. SCOTT RUSSELL: I have read the paper with extreme interest, and was charmed to find that such a class of young men as the one who wrote this paper, is being brought up to the service of the Navy, which we all know requires a great deal more of education than the service of past times. As to agreeing with him in everything, I think it is more the naval Officers' business to criticise his work than mine. I come here as one of those naval architects and ship-builders in whom a gallant Officer says he has no implicit confidence. But I beg to say, I came here for quite another purpose, which has been amply fulfilled. I came here hoping to hear a number of experienced naval Officers say distinctly, once for all, what I have asked them again and again to do. Now, I have heard more from naval Officers to-day of what they want their ships to do, than I ever succeeded in hearing before; therefore I go home a wiser and I hope a much better man. Now, then, in reply, I will say something which I hope will gratify you, the naval Officers who have instructed me, and I beg to say, as distinctly as I can say, that if you will please to lay down as a principle that you wish everything called a ship-of-war to be a good seaworthy ship, with good sea-going qualities, I give you my word of honour, as a professional man, that there is no difficulty in doing so consistently with all the practical purposes you want; but I must insist on your first deciding by saying, that you wish every one of your ships to be a good sea-going, sea-keeping, seaworthy ship, and therefore I am delighted with the courage some of you have had to say, that you want that. Now I say I want it most strongly, only I am not a sailor. I want it most strongly for this reason. I have been three days and three nights in the Bay of Biscay with enormous power trying to carry me ahead, and I have been fifty miles further astern at the end of the three days and three nights' work than I was when I began. Now I ask you, do you mean to say you will dare to call any ship a decent ship-of-war that cannot hold her own, and that cannot go ahead against any wind that is blowing? I do not. And as I know that no ship can hold her own in a decent storm, such as I am familiar with, which cannot go an honest nine knots an hour, so to say, that any one who will permit a ship-of-war to be built of any sort that goes less than nine knots an hour, is doing a thing which I, as a ship-builder, would entreat

you not to do. Therefore, pray do keep to it, that every ship shall be a good sea-going, sea-worthy ship, and that she shall have such speed and such power as to enable her to keep the sea in all the probable circumstances which may occur to her. You say next, she shall be an unsinkable ship. Allow me to say, that you have only to have the courage to demand it, and take a little trouble to look into it, and try to find out how it can be so contrived that it shall do what you want, and have the least practical inconvenience, and I tell you again, upon the word of a professional man, there is no difficulty whatever in building you not only a seaworthy and sea-going ship, but a perfectly unsinkable man-of-war; and the reason I say so is this, that I have built ships again and again intended to be unsinkable ships, and I tell you that again and again these have been run down, and ripped open, and have never once gone to the bottom, or showed the least desire to go to the bottom; I then go to the next point, and I say to you, with regard to your ships, allow me also to say all you have heard about the difficulties of closing doors, and all those things, and the dangers of this, that, and the other communication and separation, these are all nonsense, because if you make up your mind that you will have it, all the means of doing it are entirely at our fingers' ends: only you won't say you want it.

The next point I beg to state is this. A great deal has been said of the bad manœuvring of fast ships. Now, allow me to say to you, that it is perfectly easy, if you wish it, to make all your ships much more handy than they now are; only again I say, go to the Admiralty, and say you must have it, and you will have it; and you will have this ship able to turn in a given circle, with a given length, and a given speed, and I tell you we know the means of getting it. The next point in the structure of those ships, for which you may throw the blame upon us, is this, our liability to have to carry ballast and useless weight. Now, allow me to say, that an infinite deal of nonsense has been talked on the subject of loading ships in order to make them stable. It is not necessary in a steam ship,—mind I am talking of a steam ship, and I am not talking of a sailing ship,—it is not necessary in a steam ship even to carry one single pound of ballast for any purpose whatsoever, except to conceal some blunder that may have been made; and allow me to tell you why I make so dogmatic and unlimited an assertion. I do so for this reason. I will suppose your ship has 1,000 horse-propelling power. May I ask you what that propelling power is? That propelling power is ballast. How many tons do you carry in the shape of water ballast in the boiler, in the shape of iron ballast, called boiler and engines, and where is all that? All that is just where you want to put the ballast. What do you want then with other ballast? It is perfectly unnecessary. Allow me also to say to you, that there is not one single calculation in the stability of a ship which (in any ships I have ever seen constructed by competent men in my profession) had the least doubt about it, and that it is as easy to measure *before* you build the ship the exact amount of stability she is to have as it is *after*. Therefore, suppose you gentlemen of the Navy say beforehand exactly what top weight you want your ship to carry, and what amount of sail you want her to carry, and what the conditions are you want to have that ship in when she is put into your hands, and I tell you it is not the fault of these poor shipbuilders and these poor engineers if there is not every quality you desire. I shall conclude by asking you to believe that I do not talk nonsense when I say this one word. I only ask you to believe what I say upon my professional experience, and therefore I beg to tell you a secret. Almost all the ships I have built in my life (and I think I have built perhaps 150) I did not build as common shipbuilders build them. I did not build them on so much money for so much a ton of ship,—I did quite another thing. I always made the man who wanted the ship tell me how much he wanted her to carry; what voyages he wanted her to go; what work he wanted her to do; what speed she was to have; what, in short, it was his purpose to do. And I never made a contract with him as to how it was to be done, but I simply said, "Well, if you give me so much money I will put a ship into your hands which does all you want." That is the way in which I built every successful ship I ever built in my life; and I say, in like manner, if you, instead of getting out specifications of this, that, and the other details of construction, will only come together, and write down on a piece of paper

what you want the ships to do that you are to command when you go to sea, I guarantee that I know plenty of men who would give you exactly the ships you want.

The CHAIRMAN: I think that we have now gone through the subject pretty fully, and I am sure we shall all agree to thank the Essayist. Whether we do or do not agree with the details, we must all be gratified that an Officer, and one so young, has devoted so much of his time and talents, and has done it so successfully as Commander Noel has done in this Essay. I am sure it is extremely creditable to him, and we owe him our best thanks.

LECTURE.

Friday, April 28th, 1876.

MAJOR-GENERAL SIR GARNET WOLSELEY, K.C.B., G.C.M.G., &c., &c., in the Chair.

THE TACTICAL POWER OF MODERN FIELD ARTILLERY.

By Lieut.-Col. C. B. BRACKENBURY, R.A., A.A.G., S.O.G.I.

ACCORDING to a fashionable theory of philosophers, the life of a nation is an exact copy of that of an individual, and passes through the various stages of candid but credulous childhood, poetical and studious youth, vigorous manhood and grasping but feeble age. We were told by "the greatest, wisest, meanest of mankind," that "in the "youth of a state, arms do flourish; in the middle age of a state, "learning; and then both of them together for a time; in the declining "age of a state, mechanical arts and merchandize." According to this saying we English, nay, we Europeans, ought to be in a condition of decrepitude. But, for my part I can see no signs of it at present. The roads that run from town to town and village to village favour the march of armies; the railways that render our trade easy and the existence of such cities as London possible, serve to collect and feed monstrous bodies of troops; the telegraphs carry the orders of commanders as well as the messages of traders; if the sea is covered with steam merchant ships, it bears up also heavily armed ironclads; and, while the present perfection of mechanical art produces a thousand luxuries hitherto undreamt of, it has also rendered possible the development of artillery.

I do not propose to inflict on you even a sketch of the history of field artillery, but it is necessary for the understanding of our subject that we should bear in mind how modern anything like a manœuvring field battery is. As late as 1799, the artillery train dispatched with the expedition to the Low Countries had to be improvised for the occasion. The guns, attached in pairs to battalions, were drawn by heavy horses driven by Dutch waggoners who walked beside their teams with long whips. Though Napoleon the First improved his artillery so that he and his Generals won great battles by its daring employment in masses, we English entered on the Peninsular war with our field artillery in a very poor condition. Shortly after the commencement of the Peninsular war, Wellington wrote: "I shall be obliged to "leave Spenser's guns behind for want of means of moving them, "and I should have been obliged to leave my own if it were not for "the horses of the Irish Commissariat." A little later, before the battle of Vimiera (1808) he said: "Our artillery horses are not what

"we ought to have; they have great merit in their way as cart-horses "of dragoons and Irish cart-horses, bought for £12 each! but are "not fit for an army that, to be successful and carry things with a "high hand, ought to be able to move." The carriages were in no better condition. Napier says that the pursuit of the enemy after Vimiera had to be stopped because "the artillery carriages were so "shaken as to be scarcely fit for service."

Even so late as the battle of the Alma the guns sent over the river at a critical period had to be worked partly by officers because the gunners toiling on foot could not keep pace with them.

In the present day even field batteries can move for short distances at a gallop, carrying the gunners requisite for the service of the pieces, while the fire of the guns has increased to an extent which would then have been considered impossible.

Therefore, in trying to estimate the modern place of field artillery, we need not study old wars, but may confine ourselves to examples taken from the last war between France and Germany. The battles round Metz are especially interesting both because the Germans there met the flower of the French Army, and because a German artillery officer, Captain Hoffbauer, has given us a most careful and instructive account of the work of his own arm in those engagements. The instances we are about to examine are not all set before you as examples to be followed; some of them only show what is possible, not what is to be recommended.

Borny.—Few battle-fields could be more unfavourable than that of Borny for the action of artillery. It was intersected by ravines, water-courses, enclosed villages, vineyards, walls, plantations, and hedges; in fact it is one of those battle-fields where artillery can, as a rule, move only on the roads. The action commenced by a most plucky attack made by the advance guard of the 7th corps, the object of the corps Commander being to grip the enemy and force him to suspend his retreat from the right bank of the Moselle, and so give more time for the turning movement of Prince Frederick Charles.

The French were very superior in numbers at first, and remained more numerous to the end of the day even when all the available Prussian troops had come up. Moreover, they were fresh troops and fought with the knowledge that they could, at the worst, take shelter under the guns of Metz and her forts, even if forced to give up their strong defensive position.

Yet, in spite of all disadvantages, we find the artillery pushed well forward at first, and reinforced as soon as possible by the batteries of the I. Corps sent on at a rapid trot *far in advance of their infantry.* We find the batteries falling naturally into groups or masses whenever it was possible, and holding their own against both infantry and artillery fire. We find one of the masses limbering up under fire and moving to the right flank, which was threatened by the extension of the French left. An episode is well worth remembering. The right wing of Von der Goltz's brigade had dashed into a small pine wood, but found itself attacked and surrounded by heavy forces of the French. Hoffbauer's battery moved at once to a position about 800 yards from

the enemy, and opened fire to extricate the infantry. The result is thus stated in his own words:—

"The enemy's columns suddenly disappeared, and their place was "taken by long lines of skirmishers, one behind another; mitrailleurs "and guns also opened fire. For a few minutes the battery was "exposed to a heavy fire from skirmishers in the vineyards of La "Planchette, adjoining the defile of Montoy, but opening fire with "case *at* 400 *paces*, it cleared the ground."

The losses of the battery were considerable. Three Officers were wounded, and all the Officer's horses but one killed or wounded; but the desired effect was produced and the battery continued in action throughout the day. Its losses in this action in killed and wounded were 29 Officers and men, and 28 horses. The total combatant force of a Prussian battery is, or was then, 66 Officers and men, and 48 horses.

The total artillery losses in the battle were 138 Officers and men, and 158 horses. The damages to material were only one gun-carriage, one limber, and three wheels broken, though the ground was often dangerous to travel over.

You will find the scanty losses of material compared with men and horses a very marked feature of artillery combats, quite sufficiently marked to base tactical reasoning upon as I shall do hereafter.

Mars la Tour, Vionville.—The battle of Mars la Tour or Vionville on the 16th August was, like that of Borny, undertaken to check the supposed retreat of Bazaine's army from Metz to Verdun. The Germans were not aware that the French had four Corps close at hand, though we cannot be sure that such knowledge, if obtained, would have materially altered their tactics. Their faith in attack is profound, and the French army had to be held fast at all hazards to prevent its junction with MacMahon's retreating columns, and the troops assembled at Chalons.

The battle commenced by the arrival of the advanced guard of the 5th cavalry division near Tronville. Its battery immediately opened fire on hostile cavalry near Vionville. Some of the French cavalry were watering their horses, and the streets of the town were full of baggage. The result was a panic. A French battery presently replied. The three Prussian batteries with the main body rushed on to range themselves beside their comrades of the advanced guard, and drove back the enemy. Meanwhile, as usual, the artillery of the nearest Infantry division was ordered forward by the Corps Commander, and the battery of its advanced guard soon occupied the position near Tronville, taking the place of part of the Horse Artillery which was pushed on to the hill at Vionville. After a few rounds they again pressed on close to Vionville; but the French now advanced with swarms of skirmishers, reoccupied Vionville, and pushed through the village against the guns. The two batteries closest to the village having no friendly infantry near them, were ordered to draw back under cover of the hill; but Müller's battery—one of those which had come forward from the infantry division, and was now not far off—moved up close to the village and came into action under a heavy fire,

several horses being killed or wounded. "Swarms of skirmishers again "rushed out from Vionville, and the moment became critical. The "battery had recourse to case, and succeeded in driving the enemy back "into the village; but as the close and biting musketry fire continued "to make many casualties, it retired some 300 or 400 paces and took "up a fresh position." So here we have an example of batteries quite unsupported by infantry, yet holding back large forces of the enemy's infantry. However, the French continued to gather in swarms, and the artillery had to fight a delaying action, retreating here, advancing there, till the Prussian infantry came up.

After this, and throughout the battle, the guns continually checked the advance of French bodies of troops, while on the other hand it is remarkable that they often suffered greatly from the fire of infantry at 1,200 to 1,600 paces.

It is sometimes said that the fire of artillery has little physical, but only moral effect. Let me quote a paragraph from Hoffbauer's account, later on in this battle:—"Two dense columns of infantry, "issuing suddenly from buildings to the north-east and south-east "(of Flavigny), were shelled by the whole of the batteries at a range "of 1,500 or 1,600 paces, and retreated to Rezonville, leaving the "ground literally covered with corpses, while strong French columns, "which advanced from the hill to re-occupy the village, shared the "same fate." Next day the neighbourhood of Flavigny was strewn with bodies of men, and of a large herd of cattle, which had fled from the farms, torn and mangled by shells.

It is not my business to describe this or any battle, only to give you a few suggestive incidents. We find Captain Müller *withdrawing* his battery some 200 paces, so as to bring it *into line with the skirmishers of infantry*, which had already retired. Again and again we find artillery pushed forward within short distance of the enemy to disengage exhausted or overwhelmed infantry. We find a battery coming successfully out of a struggle in which it lost so much from the fire of mitrailleurs that "two guns were rendered temporarily useless by "want of gunners, and three guns lost so many horses that they "could not be moved." When Wedell's Infantry Brigade advanced from Mars la Tour, and lost 65 officers and 2,600 men out of 85 officers and 4,500 men—more than half its strength, being utterly overwhelmed by numbers—the three supporting batteries had to risk everything to extricate the infantry. Two of them held their ground till the enemy's infantry were actually close to the muzzles of the guns. They were saved in their turn by gallant charges of cavalry. But they were saved!

During the latter portion of the battle, nineteen batteries (114 guns) held the line between the Bois de Vionville and the high road beyond Flavigny, supported attacks, and always checked pursuit, because so long a line can play at once on the front and flanks of the advancing enemy. Remembering how overmatched the Germans were in numbers, it is not surprising to find that the casualties were so numerous that "drivers, and even officers, had to work the guns, some "of which had temporarily to cease firing for want of gunners."

Most of the teams were reduced to two horses. Yet they were not driven back, and in the evening some of these batteries were actually sent forward to attack. It was so dusk that at 100 paces enemies could not be distinguished from friends. More than once they blundered into the presence of the enemy, and saved themselves by shell or case.

At the close of the battle the artillerymen were for the most part exhausted, many of the men being almost blind and deaf. Most of the guns were very foul, and several instances of shells jamming in the bore had occurred in consequence.

The losses in killed and wounded were 42 Officers, 685 men, 1009 horses,[1] an average of one Officer, 18 men, and 38 horses per battery—that is to say, more than one-fourth of the men and more than three-fourths of the horses. One battery lost 4 Officers, 42 men, and 50 horses, or about three-quarters of its Officers and men, and more than its complement of horses.

The losses in material were quite insignificant—one gun carriage, 5 limbers, 8 wheels, a pole, and an axletree seat damaged. They had fired about 20,000 rounds, of which 19 were case. Want of ammunition was often experienced.

The ranges were various, from more than 4,000 paces to 800 frequently, and more than once 300 or 400 paces. The enemy often advanced under fire to within 800 or 900 paces, say, 700 yards, but were almost always checked at about that range. And the instances of short ranges generally occurred at decisive moments, when no attention could be paid to cover.

Gravelotte.

The battle was commenced by the IX Corps sending on through Vernéville the artillery of the 18th Division and the Corps Artillery, escorted by two squadrons of the 6th Dragoons, to the hill beyond the valley N.E. of Vernéville, within effective range of the enemy, who were near Amanvillers. The battery of the advanced guard pushed on and opened fire from near the road N. of Vernéville, but shortly after the Divisional Artillery came up at a trot (not Horse Artillery, mind,) and, crossing a rather difficult ditch at a gallop, came into action 1,000 paces further forward, and fired at hostile batteries to the west and south of Montigny la Grange. Presently the Corps Artillery came up at a trot, and ranged itself on the left of the Divisional Artillery, along the hill between Vernéville and Amanvillers. The enemy replied from batteries under cover, mitrailleurs, and infantry fire, at 1,000 paces, pushing forward skirmishers even closer. The fire was so hot that the escorting two squadrons of dragoons were sent back to Vernéville. Many Officers and men fell, but the guns retained their position, and drove back the French infantry.

Now, the left of the line had been pushed so far forward, acting on the supposition that they had only the right wing of the French Army to deal with, that it soon found itself under fire from French Artillery

[1] Fighting strength, 66 officers and men, 48 horses.

and mitrailleurs on the left and in rear. The left battery, Werner's, retired a few paces, wheeled outwards, advanced 200 paces, and opened fire in reply. But in less than half an hour it lost two Officers, three-fourths of the men, and all the horses except eight. It had, however, silenced the enemy's mitrailleurs at a range of 900 yards, when suddenly a French battalion, which had been concealed in a near hollow, appeared close to the battery, "like figures on a stage." There was no time to fire even with case. Only eight horses were unwounded, yet Captain Werner saved two of his guns. The French battalion pressed on to the flank of the next battery, whose commander, occupied with his own struggle, had not perceived the fate of Captain Werner's battery. As soon as he felt the fire of the chassepôts, he turned his guns upon the French battalion and disengaged himself, by firing shell at close quarters. Deciding on instantaneous retreat, he saved all his guns and left only one limber on the field, all its team having been killed. Of course he suffered severely, "unexampled loss," Hoffbauer calls it.

Now, Gentlemen, here are two batteries surprised by infantry at close quarters. They are entirely without support. In one case all the horses but eight and three-fourths of the men are already killed or wounded. This battery carries off two guns. The other battery suffers great losses but carries off all its guns.

Then German infantry arrived and the rest of the batteries were ordered to withdraw one by one to make good their losses. This they did "with reluctance." Two went and the next one was attacked by French infantry at 400 paces. It fired case, checked the enemy, and under command of a lieutenant, followed the rest. Horses had to be sent for from waggons for the next battery, and infantry fired on it in flank and rear, the German infantry—a battalion pushed forward after a time to help the guns—*having retired through it.* Two of the guns sustained such losses in limbering up that they could not move with the others. A lieutenant remained with them and brought them off after some further loss. Twenty-seven Artillery Officers had been killed or wounded in this affair, others had lost horses, one limber was blown up. Remember, this line of guns had been pushed right into the midst of the enemy. French infantry and mitrailleurs were in front, on both flanks and in left rear. It was a Balaklava Charge, with artillery instead of cavalry, yet all the guns were carried off except four from the left battery, which were actually among the enemy, and only two were permanently retained by the French. But for lack of horses at a critical moment, not a gun would have been lost. To show the severity of the French fire at this time, it may be sufficient to say, that the German fusilier battalion, sent to extricate the left wing of the artillery, lost in twenty minutes more than half its numbers and had to retire.

On the other hand we read that when the Saxon corps were advancing, after the storming of St. Marie aux Chênes, two batteries which were pushed forward, "sustained considerable losses from the "enemy's artillery, and especially *from swarms of skirmishers which* "*had ensconced themselves in the folds of the ground* towards Ran-

"court." Two Officers were wounded, two guns very soon lost all their horses and nearly all their gunners. The batteries retired but came into action a little further back.

After all the Saxon artillery were in position, the enemy made repeated attempts to dislodge them as well as other portions of the German artillery, which were now massed in the neighbourhood, but the value of large masses of guns now became apparent. Whatever point the French selected to attack, their way to it was not only covered by the direct fire of the guns against which their assault was directed, but also by the flanking fire of other parts of the great artillery line. Hoffbauer says, "as a rule the ranges varied from "1,800 to 3,200 paces, but they were often much shorter, as for "example, when the enemy's skirmishers, advancing against our "front to within 800 paces, were completely stopped by the German "shells."

Speaking generally of the artillery pushed on in the early part of the battle, Hoffbauer tells us, that "the principal losses were caused "by the chassepôts of skirmishers, who lay under cover in the "furrows, as well as in the ditches of the high road."

Towards the right of the German position the first Army massed 156 guns, with the fire of which it completely crushed all efforts of the French to advance, and became so emboldened that it attempted to push both infantry, cavalry, and artillery through the defile of Gravelotte, not understanding that immense masses of the enemy commanded by their fire both the defile itself and the exit from it. Some batteries got through with loss, but found themselves in a perfect hornet's nest of Frenchmen. I cannot forbear giving you a rather long extract, relating the fortunes of one of these batteries. The order for it to advance was a mistake, but the conduct of the battery is worthy of immortal honour. Three Officers had been wounded, all the Officers' horses had been killed, and the battery had suffered enormous losses.

"But in spite of the losses both in men and horses, which increased "from moment to moment, the battery not only bravely held its "ground, but also maintained its fire with great effect. Shells were "thrown at from 700 to 900 paces, against hostile skirmishers in the "hollow road, and at 1,100 paces against Moscou, as well as at shelter "trenches and mitrailleurs east and west of that farm.

"Perceiving the desperate situation of the battery, Lieut.-General "Von Schwarz sent his Adjutant through the storm of bullets with an "order for it to withdraw across the defile. But so many horses had "already been disabled that the battery could not be moved, and "Captain Hasse affirmed that death was preferable to leaving the "position unnecessarily. The firing was therefore continued, till at "length but one gun could be served, and that by four men only; for "all the gunners of the other detachments were either killed or "wounded. The ammunition of its own gun-limbers, as well as that "of a limber of the fourth light battery, was exhausted, and there "was no more at hand, the lines of waggons not having been able to "pass the defile."

At this moment the Divisional Commander arrived with three waggon teams, and repeated the order to retire.

"Having refitted under fire, as far as was absolutely necessary, the "battery then retired through the defile, its limbers riddled by "bullets, the drivers on foot, the guns drawn by two or four horses, "and closely packed with the severely wounded. The movement was "made at a walk, and further losses were sustained. Major Coester "(the Divisional Commander) had a horse killed under him; the last "gun was suddenly reduced to one horse, and, heavily laden with "wounded men, was obliged to halt for assistance. The battery "was received at Gravelotte with a loud hurrah, and General Von "Schwarz embraced the Commander with emotion in the presence of "the troops. The retreat of this heroic battery was a triumphant "march in the real sense of the word."

Another of the batteries which had crossed, though suffering heavy losses, was partially protected by a low wall, and was able to hold its ground. Its only supports at first were some weak detachments of Infantry, and though further reinforcements were sent, they were invariably cut to pieces as soon as they reached the dangerous point by the tremendous fire to which they were exposed!

After a time the French advanced in force, driving before them hundreds of stragglers from different German battalions, who had been in or about Saint Hubert. These runaways rushed through the battery crushing men and horses together, and obscuring everything by clouds of dust. "Captain Gnügge, utterly powerless, saw part of "his battery swept away in the general confusion; and when the "turmoil was over, three guns without limbers, and another unhorsed "limber, were all that remained of the battery in its original posi- "tion. Collecting, however, a few gunners and infantry men, about "thirty in number, he opened fire with case at a distance of from 300 "to 500 paces on the pursuing skirmishers, and repulsed them." This battery remained in its position until darkness made it impossible to lay the guns.

During the first attack of the Guard upon St. Privat, the Germans succeeded in seizing a part of the hill with a detachment of the 4th Brigade, which was presently attacked by strong columns from Amanvillers. The important point was in danger of being lost, and there was a great longing for the support of artillery. "But the cry "from the hill for support had already reached the 2nd Battery of "the Guard. Without waiting for orders it advanced up the slope, "and coming into action near the hard-pressed infantry, maintained "the important point against all attacks. In its advance three guns "were temporarily left behind, one of them having lost all its "drivers. In this position the battery fired on the hostile columns "and skirmishers at a range of 800 paces with such effect that they "were compelled to halt." But time would fail us were I to attempt to describe all the striking incidents of the action of artillery in this remarkable battle. We can only notice further two or three important facts.

The artillery was as usual employed with great boldness and in

masses. The First Army had at one time 28 batteries—168 guns under the same command, and in the same position. The final assault on St. Privat was prepared by the fire of an encircling mass of 186 guns, to which four batteries were added at the commencement of the assault, so that there were at that moment 210 guns concentrating their fire on the devoted position.

After the capture of St. Privat, the artillery pushed on to hold the advantage gained. Thus was formed by degrees the last great artillery mass extending from the Forêt de Jaumont by St. Privat to the Bois de la Cusse, in which mass, finally, 38 batteries (228 guns) were crowded together. The right wing of this force—about half the batteries—by its flanking fire, without any infantry attack, constrained the 4th French corps first to change front, and then to retreat.

The ranges in this battle varied between 4,000 paces (in one case 5,000) and 800 paces, for we may consider as exceptional the few rounds of case occasionally fired at close ranges.

The losses of the artillery amounted to 988 Officers and men killed and wounded, and 1,563 horses.

They had fired 34,680 rounds, of which 20 were case.

The casualties to material—besides the 2 guns taken by the French—were:

2 gun carriages, 5 limbers, 2 limber boxes, 16 wheels, 3 breech pieces, and 1 elevating screw.

Such a list appears ridiculous, but losses of material are always trifling compared with the number of men and horses killed and wounded.

Sedan.

Near the beginning of the battle, the German official account says:—

"The artillery had taken part in the engagement side by side with "*the foremost detachments of infantry.*"

Here we have the usual pushing on of the artillery at first; but listen to what comes later:—

"The artillery position of the 2nd Bavarian Corps at Frénois had "been reinforced by the Crown Prince's order, at 1 o'clock, * * * so "that 71 German batteries—426 guns in all—combined their fire from "three different sides upon the French Army, which was now crowded "together in a confined space. (In the north, 14 batteries of the 11th, "12 of the 5th Corps; in the east, 15 batteries of the Guard Corps; 7 "Saxon and 2 Bavarian on the left bank of the Gironne; 4 batteries of "the 8th Division and 6 Bavarian batteries west of La Moncelle; in the "south, 11 batteries of the 2nd Bavarian Corps in the ground between "Wadelincourt and Villette). Not only their batteries and foremost "lines of infantry, but also their reserves moving backwards and "forwards, and the masses of cavalry vainly seeking cover, were "overwhelmed with such an iron hail, that they fell more and more "into disorder, and found their power of resistance well nigh broken "before they were even able to engage in the struggle. The fate of

" the battle was already, to a certain extent, decided by this deploy-
" ment *en masse* of the German artillery, even without the further
" advance of the infantry."

A little later, the official account says:—

" And so annihilating was the fire of the artillery, that the French
" were scarcely capable of any organized resistance, when the German
" infantry, towards 3 p.m., moved forward from all sides against the
" wood."

Again:—

" But before these measures could come into operation, the already
" enfeebled strength of the enemy was utterly broken by the annihi-
" lating fire of the German artillery. The French Commander-in-
" Chief, from his position at Balan Church, saw the troops which he
" had brought forward gradually melting away."

In the general retrospect of the battle, the official account speaks thus of the artillery work:—

" The German artillery, in the battle of Sedan, produces an espe-
" cially grand and decisive effect. Only the surprise, undertaken
" during the morning-mist towards Bazeilles, as demanded by this
" sort of attack, is made by the infantry alone; but at all parts of
" the extensive battle-field the whole strength of the batteries was
" from the first brought into play. Inserting themselves in the
" columns of route in a position favourable to early deployment, they
" hastened forward to the battle-field *with the advanced parties of the*
" *infantry*. The batteries of the 11th and 5th Army Corps, which
" have to traverse the difficult road defile at the Bois de la Falizette,
" deploy, trusting mainly to their own strength, in one long line,
" though opposed to the hostile masses of horse threatening them, and
" with their backs to the Belgian frontier. As a general rule, the
" attack of the infantry is deferred until the artillery has produced its
" full effect. From the Calvaire d'Illy, the enemy is almost exclu-
" sively driven off by the fire of the guns, whereupon a few companies
" take possession of this important height without a struggle. The
" shells bursting thickly in the Bois de la Garenne prepare the
" attack of the battalions of the Guard, and spare the tremendous
" losses with which previous victories had been purchased."

Pray remember, that this is not written by an artillery officer. It is the voice of Von Moltke, speaking through the historical section of the General Staff.

Let us now try to gather together the main lessons to be learned from these battles.

The artillery was as a rule pushed forward in advance of the infantry, with the object of gaining time and establishing a superiority of fire early in the battle, so that the infantry should suffer as few losses as possible, and not be delayed longer than necessary before attacking. This was done in every case, whether the enemy were superior or inferior in strength.

We find the artillery always able to hold its ground when attacked by infantry in front in any formation, even as skirmishers, but suffering terribly, and sometimes obliged to retreat from infantry lying down

behind cover, or in folds of the ground. In such cases there was always felt the want of some troops fitted to dislodge the annoying skirmishers.

Good work was done at both very long and very short ranges, from 4,000 paces (about 3,200 yards), down to 300 or 400 paces. Whenever it was possible, the batteries closed to 1,000 or 1,500 yards, but frequently the nature of the ground, or their position on the flanks of long lines, prevented anything like near approach to the enemy.

The shortest ranges for offensive purposes varied between 1,200 and 800 paces.

The artillery on several occasions broke off from the fight in which it was immediately engaged and made flank marches in presence of the enemy. But here we must remember that the French artillery was decidedly inferior.

Whenever it could be done, the batteries were massed in long lines, under the fire of which nothing could continue to exist in formation, and this habit became more fixed as the Germans gained experience.

The losses were almost entirely in men and horses; the batteries continued in action at the same place after extremely heavy losses, and, if too hard pressed, succeeded in carrying off their guns.

Guns sometimes held their ground when infantry had to retire. We shall come to the reasons for this hereafter.

There are no means of ascertaining the actual losses of the enemy by artillery fire. If we could know them, they would be found trifling compared with what they will be in the next war, for the Prussians had no shrapnel, only common shells, and no range-finders. Their guns were not so powerful as ours, or as theirs are now.

Since the war of 1870, artillery has made certain definite advances. We shall see the effect of them the next time two great nations take up arms. Meanwhile, for want of actual war, we must get what light we can from the experimental practice carried out from time to time. We have gained some valuable facts from the practice at Okehampton. Let us examine them for a few moments.

Experiments at Okehampton.

We need not spend much time over these experiments, but we shall never understand each other unless we agree, or nearly so, as to the amount of practical decisions we have the right to deduce from such trials. And first we must clearly separate the work on Dartmoor from that usually carried out at the Shoeburyness experiments, about which we sometimes read in the papers. The experiments I am speaking of at Shoeburyness are undertaken to try the actual power of a gun or a projectile under certain definite conditions. They are purely scientific, and as the astronomer must have his instruments marked and moved with the extremest accuracy, as the chemist must weigh his simple or compound materials to the thousandth part of a grain, so must the scientific gunner spend much time and trouble in obtaining accurate results on which to base his calculations.

At Okehampton, on the contrary, every endeavour was made to bring the conditions as nearly as possible like those of war, always

remembering that the fire of the enemy cannot be imitated. The ranges were not measured by any other means than those which will, I am glad to say, soon be in the possession of every battery.

The fire was sometimes rapid, sometimes slow and deliberate, as it would be in war. The ground was very rough. The batteries came into position at all sorts of paces, and sometimes the targets were so placed as to be all but invisible; or, what is worse, they stood out against the sky-line in such positions that shells passing over them burst at unknown distances. The batteries were not selected nor specially trained for the purpose. Do not imagine that there was any desire to make the best of the occasion for magnifying the power of artillery. Such an attempt would have been as unworthy as it would have been futile under the experienced eyes of many critics. And, in the details I am about to bring before you, trifling hits are not counted as disabling men. We will only take a few examples to illustrate the power of guns at different ranges. To compare them mentally with the ranges of the German guns in actual battle, we need only remember that the length of paces to yards is about as 4 to 5, so that 4,000 yards and 5,000 paces are nearly equal. I take the 16-pounders in all cases, because the 9-pounders of the Horse Artillery were new guns which had not yet received their proper tangent-scales.

At 4,000 yards against a small cavalry column (represented by targets) 53 yards deep, using percussion shells in all cases:—

6 water-shells fired as a salvo gave	48	hits.
6 shrapnel	140	„
12 water-shells fired independently	165	„
12 shrapnel	189	„
Total 36 rounds and	542	„

At 3,000 yards against a body of infantry, about 400 hundred men, supposed to be in reserve, and represented by the famous dummies, 18 shrapnel with time-fuzes disabled 109 men.

So far the dummies were standing. Now for a crucial test.

At about 2,000 yards (1,950), the dummies being so placed as to represent a half battalion of infantry in two lines, the first line kneeling and making every use of cover, some of the men hidden by rocks, the second line *lying down* 50 yards behind the first:—

36 shrapnel with time fuzes disabled 44 out of 103 in the first line, and 6 of the second line lying down.

At 2,000 yards against targets representing 288 mounted cavalry soldiers in column of squadrons, the frontage being 36 yards and the depth 53:—

In nine minutes 36 water-shells gave.....	3,892	hits.
In five „ 36 shrapnel „	1,574	„

disabling in the first case 186, and in the second 131 men.

Many of the hits were not deadly; but, on the other hand, many of the men were killed over and over again by different shells. Each of the squadrons was severely hit, and at all heights from the ground, so that a column of infantry would have suffered equally.

I need not trouble you with the effect at the ranges generally supposed to be best for artillery—namely, between 2,000 and 1,000 yards—but come at once to short distances.

A battery under some cover was supposed to be attacked by infantry advancing from 1,000 yards to 100. At 1,000 yards only the first line of 100 men in open order and supports about the same number, came under the fire of the battery, and were allowed four minutes to advance 400 yards. They could not have moved faster, for, in the four minutes, the range being always 1,000 yards, the projectiles, shrapnel with time-fuzes:—

71 men out of 100 were disabled in 1st line
24 „ „ 2nd „

It may be said that men moving would have been more difficult to hit. But this is not the case, because shrapnel at short ranges covers with its shower of bullets a large depth—400 or 500 yards, so that to have the true range is of very minor importance so long as it is not taken too long.

The infantry were then supposed to be at 600 yards, and in two lines, about 150 to 160 in each line, always with open files, rank entire; and the artillery detachments were reduced by 3 men each to represent losses—a liberal reduction. Shrapnel was again fired:—

In two minutes 98 were disabled in 1st line.
„ 36 „ 2nd „

Again the range was shortened to 400 yards, and there was a further reduction of 2 gunners per detachment. Shrapnel were fired:—

In two minutes 117 men were disabled in 1st line
„ 39 „ 2nd „

The infantry had now lost 385 men out of 400 in eight minutes.

At 200 yards only one line was supposed to exist, additional men having come up from some other force. The battery fired case—another gunner having been removed from each detachment:—

In one minute 81 men were disabled out of 156.

The range was then reduced to 100 yards. Shrapnel were used, but put into the gun reversed, so that their percussion fuzes were next the cartridge:—

In one minute 113 men were disabled out of 156.

Thus, at short ranges from 1,000 yards to 100, the infantry never showing more than from 200 to 300 men in open order, and latterly much less:—

In ten minutes firing 579 men were killed or severely wounded, many of them struck over and over again at the same range.

Taking into consideration the whole of the experiments I have put before you, is it too much to say that the fire of an English battery of the present day (and we hope soon to outdo all this) begins to be effective at about 4,000 yards, is very powerful at 2,000 yards, and may be said to be annihilating to troops in any formation at 1,000 yards and under. The ground must of course be supposed to be moderately open.

The question then arises, what would the infantry have done against the guns? Well, Gentlemen, we are not left entirely without knowledge on this point also. Last year (1875) certain experiments were conducted in India, among which not the least interesting were the attacks of infantry against guns in shelter-pits, and I will give you the results. But let us bear in mind that the infantry also had no enemy firing at them.

On the 25th of February, 40 men of the 48th Regiment were placed at 800 yards from two gun-pits, containing imitations of guns and dummy gunners, all posted as serving their guns, whereas in reality the men would have been more than half the time under cover, to say nothing of the cover afforded by smoke. The infantry fired for five minutes:—

Result.—Three men hit in each gun-pit.

On the 13th of March, 40 picked marksmen from the 76th and 107th Regiments fired for five minutes at two guns in pits. The men selected their own positions, about 750 yards from the guns:—

Result.—5 men hit in one pit, 0 in the other.

On the 25th of June, 40 men of the 45th Regiment fired at two guns in pits for five minutes. Range unknown, afterwards ascertained to be 770 yards:—

Result.—1 man hit in one pit, and 0 in the other.

On the same day the experiment was repeated, the 40 men being in skirmishing order. The range is not given in the official report, but I suppose it was the same as before—770 yards:—

Result.—3 men hit in one pit, 2 in the other.

These results give us an average loss of 2 men per gun in five minutes, and show that the reduction of 3 men per gun made in the Okehampton experiments to represent the effect of fire from infantry advancing from 1,000 yards range to 600 in four minutes, was rather over than under estimated, especially as the first line would have lost three-fourths of its strength. Remember that not more than a few men at a time can see the gunners if they have any cover.

Here we have to face the great question of the comparative physical and moral power of infantry and artillery, and the moral effect produced upon one or the other arm by equal losses.

Before attacking this subject, permit me to say that, in my humble opinion, the principal arm, the mainstay of an army, is, as it has been and must be long after our time, the Infantry. It is the easiest trained, the cheapest to place in the field and to keep there, the only arm which is equally powerful at rest or in motion, the most easily concealed, the simplest in its armament and use. Only infantry can decide battles and secure the ground won. Whatever may be the increasing value of artillery, it can never supply the place of a single infantry soldier. But, on the other hand, the value of artillery has grown greatly of late years.

If the guns are of no use when in motion, their long range renders the necessity for their moving much less, and their mobility shortens the period of weakness. To get the full benefit of that range we need two additions. The first is the range-finder, which is at last adopted

in the service: the second is the telescopic-sight, a specimen of which has been brought forward by Lieutenant Scott, of the Engineers, to whom we should all wish good speed in his endeavours to introduce it. The regularity of range noticed at Okehampton was secured by a very simple arrangement, which there is no need to publish to all the world, and we have reason to believe that the flatness of trajectory, and therefore the effect at all ranges, is in a fair way towards making another considerable step in advance.

We may, therefore, take 4,000 yards as a practicable range for field-artillery. This means that a gun in action under favourable circumstances covers with its fire about 7 square miles of country, and can change its object from one point to another more than 4 miles distant from the first, by a simple movement of its trail. In other words, a column of the enemy on the right flank may be hit, and within a minute another column on the left flank, more than 4 miles distant from that at which it originally fired. Such opportunities are, of course, exceptional. No other kind of mobility can approach this. If the guns cannot fight in motion, there seems little need for them to do so.

Since 300 or 400 yards difference in range now matters little to artillery, the guns have a larger choice of positions than infantry in ordinary cases, so that they can generally find fair cover. Moreover, because they need not move much, they can make more use of artificial shelter. From such shelter they can act either offensively or defensively; whereas infantry must move out of its cover to attack, and cavalry can only attack by exposing itself completely.

This quietude of artillery enables it to find the range of its mark accurately and to fire steadily. The place where its shells burst can be seen, and the range corrected accordingly if necessary. No infantry soldier can tell whether his bullet has gone over or under the enemy, or struck the mark.

The fire of infantry is the collective fire of individual men, and depends for its steadiness on the nerve of individuals. Hands will tremble and bullets go astray after a rapid movement, even if the soldiers are not under fire. When to this is added the nervous excitement caused by the bursting of shells in front or in the ranks, and the sight of huge gaps made in the line or column, there cannot be much doubt that the average steadiness of nerve, and, therefore, the average firing must be very small compared with the steadiness of the same men on the practice-ground during peace.

The fire of artillery is not governed by the average steadiness, but by that of officers and sergeants, and less steadiness is required to lay a gun than to hold a rifle straight with its sight properly raised. How often, think you, would a man look to his sight when advancing under such fire as guns can now produce? Guns have no nerves to be shaken, and, the proper orders being given, aiming and firing is as much a matter of routine as marching. Fifty shells bursting in a battery will not shake the accuracy of a single gun, if once properly laid.

I hope you noticed how in the battles before Metz the artillery held

its ground sometimes when the infantry had to retire. You know the rule that the loss of one-third is supposed to be about as much as infantry can bear without retiring. Some of the German batteries lost three-fourths of their men, and yet held on and fought their guns. There was no difference in the men themselves. What was the reason? Simply this, that the guns did, as they always will if we let them, act as anchors to the gunners. Think how much trouble is necessary before a battery can retire. Somebody must take the initiative of giving the order, which must be repeated from mouth to mouth. Then the drivers have to perform a complicated movement, if indeed they are not under stress of difficulties because they have horses falling wounded in the midst of the teams. Next, the gunners must attach the gun to the limber—limber up, as we call it. Only then is the battery as well able to retire as infantry always is. The gun is, therefore, a moral anchor to the gunners.

But it is more than this. Each gun is the rival of its companions in the battery. In peace its gunners have cherished it. They have, in good-natured rivalry, struggled to make it first in beauty of polish and paint for itself and its carriage. They have striven to hide its defects and glorify its virtues. Gentlemen, they have called it *she*—need I say more?

Well, then, this "she" is not easily deserted, and as a gunner has no other arms, he fights his gun to the last moment. Without her, he is disarmed and helpless; with her, no matter how many of his comrades are disabled, the power of fire is almost as great as ever. And *she* remains there as steady as a rock, always throwing defiance in the enemy's face. Surely it is not difficult to see why a battery should hold its ground, if we will only let it, if we don't teach the gunners to count the preservation of their guns as an end instead of a means.

But the guns possess a quality which Nature has mercifully denied to female creatures generally—that of increasing their individual strength by combination. The effect of the guns is greatly increased by their employment in masses.

Take, for instance, the cavalry experiment at Okehampton, the model of which is before you. The effect was produced by 36 rounds of water-shell in nine minutes. Meanwhile, after the first six shells the troopers might have dispersed or galloped under cover. Had six batteries been there, the same or greater physical effect would have been produced in an instant of time, and the moral effect would have been overwhelming.

A battery of 100 guns would, roughly speaking, occupy about a mile, and in former days a mile was a long range for guns. But now a line two miles long might fire easily at the same object, and the guns at one end could protect those at the other by flanking fire. Therefore every increase of range lends a new argument to the advocates of massing tactics.

But I cannot find, either in reason or experience, any proof of a proposition which has lately been brought forward by an able writer on defensive tactics—namely, that the guns should be placed some 400 yards behind the infantry. If all the experience of the last war will

not suffice to dispel the idea, neither will Napoleon's maxims, which, however, may come to our aid. He lays down the rule that artillery can defend its own front in these words:—

"No infantry, however brave, can with impunity march 1,000 or "1,200 yards against a strong battery of artillery well placed and "well served; before they could accomplish two-thirds the distance, "these men would be killed, wounded, or dispersed."

And again:—

"Artillery should always be placed in the most advantageous posi- "tions, and as far in front of the line of cavalry and infantry as is "possible without compromising the safety of the guns."

All my pains will have been in vain if the impression remains in your minds that artillery is a thing to be protected and kept out of reach of harm. If you treat it so, it will be nothing but an incumbrance to you. Like the queen at chess, it is either a source of great strength or weakness, according to the way we use it.

Let us now try to gather our floating ideas into a few definite principles. As for details, they must vary according to circumstances.

1st Principle.

Since field artillery can move at a trot, and its fire is of great value at all stages of a battle and at all ranges, a general should endeavour to obtain a superiority of artillery as early as possible. To gain this, his whole or nearly his whole force of guns should be pushed well forward and massed at the beginning of a combat, so that it may crush the enemy's artillery in detail as the latter comes into position.

2nd Principle.

Whether acting offensively or defensively, artillery can protect its own front in ordinary open country, and should not retire before infantry unless the whole force is retreating.

3rd Principle.

But artillery can be sorely annoyed, or even caused to retire, by the fire of infantry skirmishers, well concealed in folds of ground or behind walls and trees. Therefore infantry should not attack in any formation, but, so to say, stalk the guns. And, this being granted, infantry should *always* attack guns; who knows but that they may be unsupported?

4th Principle.

The only reply to such hidden attacks, early in the battle before the friendly infantry has come up, is by the use of dismounted cavalry; or, better still, by mounted men trained to work on foot either as riflemen or gunners, and permanently attached to the batteries.

5th Principle..

Since artillery can take care of itself, provided its flanks are protected, a line of guns may be deployed, and behind it the infantry may effect turning movements to act on the enemy's flank. When such a flank attack is ready to be delivered, the mass of guns should concen-

trate their fire on that part of the enemy's line about to be assailed, till it is shaken.

6th Principle.

A system of signals should be devised and used, so as to enable a large number of guns to act simultaneously against the same point.

7th Principle.

When the infantry combat has commenced, as many guns as possible should be pushed close up to the enemy, say within 1,000 yards, or to that distance where they will find the best and nearest positions to the enemy.

8th Principle.

When artillery advances to close combat, a considerable number of men and horses should follow the batteries as near as they can consistently with keeping under cover. If this be done, there is no fear of leaving the guns in the hands of the enemy. At such moments, cover becomes a secondary consideration. Artillery, like infantry or cavalry, in close combat must count on heavy losses in men and horses, but they must determine to crush the enemy in that part of the field, remembering that "omelettes are not made without breaking of eggs."

9th Principle.

Since a frontal attack can be beaten off at any range, artillery, if it has a clear space of 1,000 yards in front of it and scouts on flanks, should not allow itself to be turned from its immediate purpose by the reported approach of large bodies of infantry. Such attacks may be neglected till the enemy comes within 1,000 yards.

10th Principle.

Range-finders, telescopes, and scouts are indispensable to the development of the full power of artillery; the same may be said of spare men, horses, and ammunition. The front line of the battery should have as few men and horses as possible, and should be fed from the rear, two or three times over if necessary.

But the great principle of all, and that which must underlie all minor ones, is that artillery has issued from its childhood and is as well able to shift for itself as any other arm. This does not mean that it is independent of the others, but that it is only dependent on them in the same sense that they are dependent on it. Cavalry should feel the way, and be ready afterwards to support the guns with the dashing self-devotion characteristic of its nature and history. The infantry should never forget that the guns in front may be sorely in need of the arm which can do everything but move quickly. Artillery is, after all, only preparing the way for the glorious strife of the foot-soldiers. The gunners are dying that the infantry may live and win the day. On the field of battle we are all brothers, and our only rivalry should be to try which can, at any sacrifice, do most for the common good.

The CHAIRMAN: Gentlemen, I think a discussion upon this very interesting subject would be of great use to the Army, who will read this lecture in various parts of the world. We have now heard the subject dealt with from an artillery point of view, and I have no doubt there are some infantry or cavalry officers present who would like to discuss Colonel Brackenbury's paper. I would especially call attention to the fact, that in the illustration Colonel Brackenbury has used with respect to firing at batteries, the guns were in gun-pits and it would not be always possible in action for artillery to construct these pits. I think it would be very advantageous if some cavalry or infantry officer present would be good enough to give us their opinions on the subject.

Major J. NORTH CREALOCK, 95th Regiment: I am not prepared to join issue in any manner with what Colonel Brackenbury has so ably told us, and I have great diffidence in offering any opinion. It seems to me, however, there is one little point Colonel Brackenbury has omitted to state with regard to the experiments at Okehampton, namely, how the guns were attacked by the dummy half battalion. Did the guns advance, or was the half battalion advanced? I am inclined to think the battery advanced. He told us that the front of the dummies representing mounted cavalry in column of squadrons was 36 yards, but what was the front of the half battalion of infantry? I do not think he stated that, because it makes a considerable difference if you box up a battalion of infantry into a compact formation. For it is evident, I think, that the losses which the infantry would experience under a more lateral formation would be considerably less. Although it is possible to move the guns, I doubt if you could the dummies, and I am inclined to think, if the batteries advanced and the dummies were halted, that a considerable difference would be the result. After listening to Colonel Brackenbury, I must say that I feel that I am rather sorry I am an infantry soldier, because I do not know what our *rôle* is to be in the future. He did, however, leave us one small loop-hole, for he said that although the front of the artillery is safe, the flank is not equally safe, and the only word of comfort is, that he admits in the battles he describes, there was sometimes a biting fire from infantry concealed in furrows and behind trees, so that, to use his own argument, I think there is still a future left for the infantry soldier. I think everything he laid down was done in a most fair way, and the result will be, I hope, that it will make us infantry officers a little more anxious to see what we can do to develop the usefulness of our branch of the service. It is quite true that, as he expressed it, the guns are a "moral" anchor to the gunners; but I go further and would add they are a "physical" anchor simply because they cannot run away, as it seems the horses are always shot. Speaking as a so-called "mounted officer," I suppose I may say our horses are likely to be shot also, and therefore we shall not be able to run away. I think on the whole, then, we are not in such a bad way as might be supposed, and that the future, for us, above all others, lies in Colonel Brackenbury's remark that "Infantry should always attack guns."[1]

Colonel Lord WAVENEY: I have not the advantage of being either an infantry or a cavalry officer, neither have I the advantage of the general practice in field artillery which has been developed so clearly by Colonel Brackenbury on this occasion, but it seems to me there is one point which might be considered. I observe as regards the experiments at Okehampton against cavalry and infantry, the frontal attack which the Colonel has developed is the only attack supposed. I do not remember that he speaks to any extent of the infantry flank attack, except to disregard it; nor is any mention made of a combination which I cannot but think may be effectively formed of light cavalry and horse artillery. Reference has been made by Colonel Brackenbury to the use of cavalry on one occasion, where he speaks of the Germans remaining quiet under the observation of masses of the

[1] It may be questioned, perhaps, if the lecturer could have drawn the same conclusion, viz., advising boldness in pushing on artillery, had the French attacked in place of remaining on the defensive—when *they did* attack—the German artillery would appear to have been greatly compromised and had the fortune of a day's fight been in the favour of the French, it is difficult to see *how* the German guns could have ever been withdrawn.—J. N. C.

French horse. These troops were almost in line, and their movement could only be that of a frontal attack. I remember some years since reading a very clever work, written, I think, by General Smith, of Her Majesty's light cavalry, and edited, as I now learn, by an officer of the Royal Artillery, Lieutenant-Colonel Henry Brackenbury, in which he lays down as the principle of his operations the combination of the advance of horse artillery with light cavalry. The matter was reduced to a mathematical proportion, as indeed all these details should be, and it was there shown how in successive movements of artillery and cavalry, important ground might be won and maintained. I cannot but think it would be perfectly possible to develop Colonel Brackenbury's principle as to the use of dismounted cavalry by an application of mounted cavalry also. I suppose the application of a corps of cavalry trained something after the Cossack fashion. The peculiarity of the Cossack attack is this: that although the soldiers are disciplined and trained to act together, they work in "schwarm;" that is to say, in clumps of horsemen, with whom it is exceedingly difficult to deal in detail. They advance in masses and retreat in masses; and if this be borne in mind that it would be perfectly possible with light guns to make a flank attack on guns on a line of a mile long to envelope them by swarms of these light horsemen, and that it would be exceedingly difficult to disperse these horsemen, who would furnish the means of accumulating an overwhelming force of fire on the flank of this long line, it will be seen that if the guns were shaken in this way it would possibly effect a very serious loss on the flanks of the line of artillery. I may ask how long it would take to wheel up to a flank so as to resist a flank attack on so long a line? There is another point which struck me particularly in Colonel Brackenbury's remarks on the concentration of guns. He says, in the last great attack in the battle of Gravelotte after the capture of St. Privat, an artillery line was formed extending from the Forêt de Jaumont, to the Bois de la Cusse, in which 228 guns were crowded together. Now, I submit this to his consideration: whether, assuming the existence of a school of officers who were trained to this massing of guns and light cavalry, not light cavalry of the regulation class, but light cavalry trained to act in the Cossack fashion—whether guns accumulated in such masses would not be deprived of their usefulness by the very accumulation to which they are indebted for their great strength in resisting a frontal attack. This is a point which has occurred to me. I derived my idea from the work that I have referred to, and it has seemed to me that very possibly such a combination as was suggested in that work which I venture to introduce to your notice, might increase the very great power that has been so satisfactorily shown to be developed in our modern field artillery by Colonel Brackenbury, by enabling a power of attack in movement and resistance combined to be developed, of which, at present, we have not seen any examples.

Colonel BRACKENBURY: I do not find much to reply to, as I am not aware that any strong criticism has been made upon what I have had the pleasure of bringing before you. There is, however, one point on which I am afraid I may have been a little misunderstood, although I tried to guard myself against misunderstanding. I by no means say that the power of infantry is any less than it has been. Nor do I wish, as I think I remarked, that one single infantry man should be taken away. I merely claim for guns that their power has been developed of late years, and that they can do certain things which they could not formerly do. But I should be the last man in the world to attempt to decry that splendid infantry which has over and over again in the fields where England has been victorious carried off most gloriously the honours of the day. I deprecate any attack on the value of infantry, or attempt to depreciate it in any way whatever.

With regard to the practical questions which have been asked, I would reply to Major Crealock that the formations of infantry at Okehampton were in every case taken as exactly as possible from the model which has been laid down for the future of the British Army, and is now carried out generally at Aldershot. The front of the half-battalion can, therefore, be easily discovered by referring to the book; but he must not forget that special occasion when the infantry was formed with front rank kneeling and behind cover, and rear rank lying down. Major Crealock also remarks that his horse, as a staff officer, and those of artillery officers, are very likely to suffer considerably. Certainly the horses do get killed, but the guns do not, and

therefore a great part of my argument went to show how there must be a front line consisting of guns, with just so many men as are necessary to work them, and as few horses as possible, with a reserve behind of men and horses, kept under cover, but always ready to supply losses in the battery, and to carry off the guns, if necessary. As for cover, it was one of the arguments of my Lecture that artillery have generally greater choice of covered positions than any other arm. Lord Waveney's suggestion of employing the cavalry like Cossacks seems to be an excellent one. I do not insist on the particular nature of the troops which should be employed, whether they should be cavalry or mounted infantry, or artillerymen, who can work both as cavalry, mounted infantry, and gunners, though I should prefer the latter. But they must be able to accompany the batteries at any pace, and to keep down the fire of such infantry as may be lying in the furrows and depressions of the ground, annoying the artillery. and even sometimes obliging it to retire when no frontal attack of infantry in formation could do so.

Lord Waveney also spoke of the weakness of the flanks of artillery. Undoubtedly they are weak, but I have yet to learn that the flanks of any arm are strong. Flanks always must be weak, and whether we have a line of guns or a line of infantry, both flanks must in some way or other be protected, or at least guarded, from unexpected attack, by having troops pushed out to give warning of the approach of the enemy. I do not think there is any very great difference between the flanks of an artillery line and those of any other line. With regard to massing guns, I think that a mistake is occasionally made in asking Officers whether they advocate the massing of guns, or the separation of guns and concentration of their fire. It comes to this, that you cannot help massing the guns; if you only push your batteries forward, they will naturally find for themselves places on the surface of the country where they can act best, and they will therefore come together by a sort of natural law.

The CHAIRMAN: The subject which has been so ably dealt with this afternoon in such a very interesting and careful manner by Colonel Brackenbury is one that I am sure you will all agree with me in thinking of the deepest interest to students of military history, and treats of a most important subject for the consideration of every soldier and Officer who aspires to any command in war. Until recently it has been customary in our service to leave the discussion and consideration of artillery subjects almost exclusively to artillery Officers; the great bulk of our Officers contenting themselves with the study of the drill, organization, and tactical requirements of their own branch of the service. In fact, until the recent great wars drew attention generally to this subject, we were contented, as an army and as a people, to consider that the question of artillery tactics had been effectively disposed of by the regulations in our drill-books, which laid down that batteries were to conform in action to the movements of the infantry or cavalry to which they were attached. You will find in the accounts of some of the most remarkable battles fought by the greatest commander in the world some extraordinary examples of a great concentration of guns. But, curious to say, from these examples we, as an army, learned but very little, although they may have been of use to a few military students, who may have deduced from them very useful conclusions for their own future guidance; but as an army we were contented with the rule in the drill-books to which I have referred. When an army was to be organised for active service in any part of the world, our Generals seemed to content themselves with attaching to each brigade and each division of the army a certain number of field batteries, which when used were brought into action, according to our regulations, with the muzzles of their guns beautifully dressed in a line upon the adjoining infantry or cavalry. This had no doubt a very striking and theatrical effect in sham fights, and was looked upon by a great number of old sergeant-majors with the greatest possible delight, but it was an ignorant use of artillery; in fact, it was not only a ridiculous and ludicrous display, but it was positively injurious to the interests of the Army, because it conveyed to the minds of young soldiers and Officers, who would look at these sham fights as a means of learning what real war was, the idea that if they went into action in command of artillery, the proper disposition of it was to have the batteries in line with the neighbouring cavalry and infantry. I am glad to say that this has now been changed. Very early in our manœuvres, when H.R.H. the Commander-in-Chief directed the general operations, he saw how inapplicable such an arrangement was to real war, and I am glad to say

he emancipated the artillery from that ludicrous obligation to which they had been tied down in former days. But although we all feel that it is as necessary as ever it has been in past times that all three arms of the service should combine together in action, it is still necessary to give to both the cavalry commander and the infantry commander a great deal of latitude of movement, if you wish to obtain from both these arms of the service all that they are capable of affording you. There is one point to which I would especially direct your attention, and that is a point I originally intended to ask you to think of when I rose, and it is a point of far greater importance. It is this: that before any Officer can really be fit to command troops in action, it is absolutely necessary that he should have thought out for himself this artillery question as thoroughly as any artillery Officer can have done so. Until he has done so, I believe it will be impossible for him efficiently, or with due regard to the interests of the country, to command Her Majesty's troops in action. As I have already said, we are, as an army, too much inclined to devote our attention to the special branch of the service in which we have been brought up. The education and training given to artillery Officers is eminently calculated to direct their attention to the solution of this problem; but there cannot be any greater error than to imagine that special training is necessary in order to solve it. I feel convinced that, as regards the tactical use and movements of artillery in action, there is no mystery whatever, and that "he "who runs may read." Any man who will bring a mind of ordinary ability to study the subject can master it, by carefully studying the history of recent wars, and by bringing his mind to bear upon the subject. He will find it to be one as easy of solution as any of the other problems in war. I think the information which has been given us upon this subject by Colonel Brackenbury is very important. Thanks to the rules of this Institution, the lectures delivered here are published, so as to be read in every garrison where British troops are quartered all over the world. I therefore feel justified, not only on the part of those I see here, but of all military students in remote parts of Her Majesty's dominions, in conveying to Colonel Brackenbury our very best and sincere thanks for the interesting and delightful Lecture he has given us.

Evening Meeting.

Monday, April 3rd, 1876.

ADMIRAL SIR HENRY J. CODRINGTON, K.C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between the 21st March and 3rd April, 1876.

LIFE.

Balfour, R. F., Captain Gren. Guards.
Dalrymple, J. H. N. G. H., Viscount, Lieut. Royal Horse Guards.
Elliot, Charles, C.B., Colonel late Madras Staff Corps.
Bacon, Sir H. B., Bart., Lieut. Gren. Guards.

ANNUAL.

Holmes, J. R., Captain 8th Orkney Art. Volunteers.
Alington, Arthur H., Commander R.N.
Home-Drummond-Moray, W. A., Lieut. Scots Fus. Guards.
Coke, T. W., Viscount, Captain Scots Fus. Guards.
Freeth, Sampson, Major-General R.E.
Bagot, Joceline F., Lieut. Gren. Guards.
Mansfield, Hon. W., Lt. Colds. Guards.
Thornton, Harry G., Lt.-Col. Gren. Gds.
Fitzroy, G. R., Lt.-Col. Colds. Guards.
Fortescue, Cyril D., Capt. Colds. Gds.
Bell, Mark S., V.C., Captain R.E.
Compton, A. F., Lieut. Gren. Guards.

ON MAGNETO-ELECTRIC LIGHT.

By Captain W. de W. ABNEY, R.E., F.R.S., School of Military Engineering, Chatham.

I MUST apologise for having undertaken to introduce the subject of the Magneto-Electric Light, as I do not believe myself entitled to speak with more authority on the subject than those Officers who have closely studied the means of utilizing it for military or naval purposes. My acquaintance with it has been chiefly in what I may term its scientific aspect; and I have, therefore, proposed in a great measure to devote this evening to those points in regard to it, which may be less generally known. The aspect in which it will be considered is capable of creating great interest if rightly demonstrated; but I fear that with my limited practice of public lecturing I shall fail to succeed in doing justice to it. The excuse I must plead for being here to-night at all is, that I was asked by the Council of this Institution to read a paper on the subject, and I consented to do so, though with much hesitancy, as they can testify.

The ordinary sources of illumination such as oil lamps, or the oxy-hydrogen light, from their small amount of power are manifestly quite inapplicable for naval, or military purposes, when it is desired to illuminate land or water from any but close proximity. To light an enemy's lines, to discover his working parties, or to sweep an area of sea in order to search for hostile boats which might be sent at night to grope for torpedoes, requires a much more powerful light than either of the two foregoing, even when concentrated by a lantern. The light emitted by incandescent particles of carbon previous to their oxidation are utilized in the ordinary candle flame, but when the heat is increased to an extent verging on the absolute vaporisation of these particles, the light must of necessity be much more intense. This intense heat can be attained by passing the electric current be-

tween two carbon points, the electricity being generated in one of two ways, 1st by a voltaic battery composed of Groves's or Bunsen's cells; or 2ndly, by magneto-electric induction, when the electrical intensity can be enormously increased. The first mode of creating the necessary current is by the rapid consumption of zinc by an acid. We know from every day experience that when coal is burnt, the carbon of it is oxidised, and the act of the combination of the carbon with the oxygen causes the generation of heat waves. Similarly, when zinc is consumed at a rapid rate by an acid in the presence of a less readily oxidizable metal, electricity is generated, causing a disturbance in the medium permeating the conducting wires; and when the disturbance meets with opposition, the electricity is converted into heat, and this again when sufficiently intense, into light.

In order to understand the action of the electric light, it must be borne in mind that heat, light, electricity, and magnetism are each of them the effects of vibrations executed in the ethereal medium which pervades all space; that they are of the same character and nature, being only distinguishable one from the other by our senses, and that they are convertible one into another. In the case before us at present, the light is caused by the conversion of electricity into heat, and thence from heat into the sensation we call light. To obtain sufficient intensity and quantity of electricity, 40 or 50 Bunsen's cells are coupled up together; and the current is allowed to find its way along the conducting wires to two graphite rods of small section, held in position in the lamp before you. The rods are now separated by about half an inch, and the quiescent state of the battery tells us that there is no fresh generation of electricity. The ends of the rods are now, however, brought together, and, as can be seen on the screen, at the point of contact they begin to glow with a red heat. The battery is evidently at work, and the heat is due to the resistance the current meets where the contact is made. The graphite rods can now be separated gently till they are more than half an inch apart, but the conditions are changed. The air between their points is now intensely heated and rarefied, and is consequently a better conductor. The current still passes, carrying with it, from one of the points to the other, carbon in a partially volatilized state. The heat is so intense that a brilliant light is produced, equal to at least 1,000 candles. A Groves's cell consists of a plate of platinum immersed in nitric acid contained in a porous cell, and a zinc plate surrounding this porous cell, both being immersed in dilute sulphuric acid. The last acid has a strong affinity for zinc, and dissolves it with the liberation of hydrogen, which is collected on the platinum plate when the zinc is connected with it by any conducting substance externally to the battery, and decomposes the nitric acid in the porous cell into nitrous acid and water. This action was shown by the nitrous fumes evolved. I now wish to demonstrate the heating of platinum *wire* by the voltaic current, as it is analogous to that which will be shown with a small magneto-electric machine. Two yards of the wire are taken and the current passed through it with no visible effect. The length is gradually diminished, and the wire becomes red-hot, then white-hot, and it finally fuzes. Could an equally fine

section of graphite be obtained, the fusion would not have taken place. The practical impossibility of fuzing graphite has led to its adoption in the production of the electric light. I may here mention that a lamp has been constructed holding very fine rods of carbon, through which a current is passed in a manner similar to that which has just been demonstrated.

There is a certain amount of manual labour necessary to put the battery together, and unless renewed, the light is only good for about three hours at a time, which is almost too short for actual work in war-time, though sufficiently long for carrying out experiments. Fifty Groves's cells require half a gallon of nitric acid, and about a quarter of a gallon of sulphuric acid; and after the zinc plates are amalgamated, to ensure a constant current, it takes about three-quarters of an hour to fill them. The light should be used immediately after the battery is made up, or a useless waste of zinc ensues, and a consequent deterioration of the light.

The second mode of production of the electric light is by the action of magnetism. If a magnet be slowly introduced into a helix of iron wire which is connected by wires with a galvanometer (an instrument which tells when electricity is passing in any circuit), the needle of the instrument will be found to be at rest. When, however, the magnet is quickly withdrawn, there will be a slight deflection of the needle for an instant, showing that a current of electricity is passing. On again suddenly inserting the magnet into the helix it will be observed that the needle slightly moves in a contrary direction, showing that an electrical current is passing in the opposite direction. It is the fact that small momentary currents are thus induced in a helix, on which the generation of the magneto-electric light is based. With a properly constructed helix and with a very rapidly withdrawn magnet, currents of a most intense character can be created.

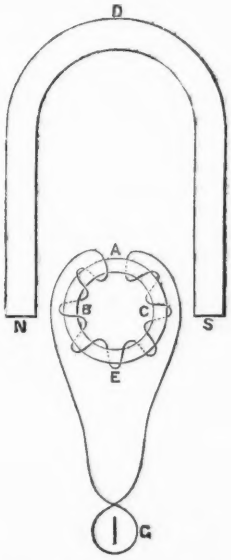
Another experiment which I wish to show is the magnetism that is induced in soft iron when a current is passed through a helix surrounding it. This rod of soft iron has no attraction for these iron nails, but when inserted in this helix, through which a current of electricity circulates, it shows magnetism by picking a bunch of them from the table. In the magneto-electric machine a portion of the current is utilized to produce this electro-magnetism, and the strength of the light-giving current depends much upon it.

Perhaps the construction of a Gramme machine may now be understood.

Let NDS, Fig. 1, be a horse-shoe magnet with its north and south poles at N and S respectively, and let ABC be a soft iron ring with a helix of insulated wire wrapped round it, and the ends in connection with a galvanometer, G. Wherever N and S are opposite the iron ring, there it will become magnetized by inductive action. Thus, in the position shown, B will be a south pole and C a north pole, whilst A and E will be points of no magnetism. Suppose the magnet to rotate round the ring, ABEC, in the plane of the paper as it moves the magnetism in the ring will shift, and the same action takes place as in the foregoing experiment: the magnet will be perpetually moving inside the

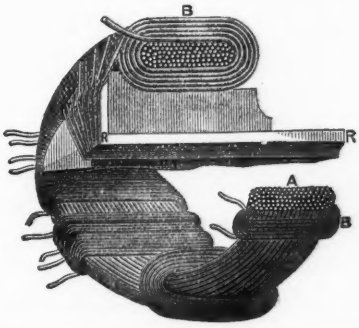
helix, consequently a current will be excited which will be shown by the deflection of the needle in one direction or the other in the galvano-

Fig. 1.



meter, G, excepting only where either N or S is opposite A. Manifestly the same result would ensue were the ring rotated instead of the

Fig. 2.



magnet, and this procedure is adopted in the Gramme machine. Instead of the wires being connected with the galvanometer, as shown

in the diagram, the helices are laid bare at parts, and copper brushes, placed at the neutral points A and E, take away the electricity as they come opposite those points. By employing a brush at each point instead of only one at A, both the negative and positive currents are utilized, and being led to the galvanometer (or through the lamp) in different directions, a greater intensity is obtained. The artifice of using the brush collectors causes the current to be continuous, though it rises and falls in intensity within certain limits.

The construction of the ring armature is shown in Fig. 2.[1] We have at A, a section of the iron ring itself formed of a bundle of soft iron wires. At B B are the helices, one in section and one detached. At R R the form is shown of one of the copper conductors to which the ends of the helices are attached and from which the current is drawn off by means of copper brushes at A and E′ (Fig. 1.) I may here state that if the brushes were placed in any other position than A and E, the current would be largely diminished, and if at B and C there would be no current at all, for then the current travelling one way would meet the other travelling the other and they would neutralize each other. By means of the great depth and closeness of the spirals a very intense current is set up when the armature revolves.

Fig. 3.

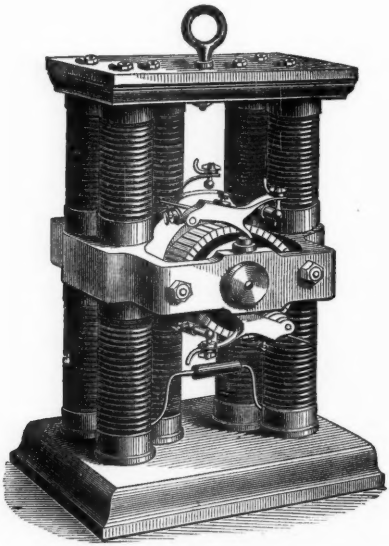


Fig. 3 gives the complete Gramme machine:—The circular ring armature is shown and it will be noticed that the magnets take the form

[1] Figs. 2 and 3 have been taken from Breguet's pamphlet on the Gramme Machine.

of electro-magnets, thus increasing the power in a wonderful degree. The armature and these act and react on one another by induction and produce a current so powerful that it is sufficient to produce the most *intense* light when passed between carbon points. The motive power is generally steam, and from theoretical considerations, it seems hopeless to expect to produce a useful light by the direct application of human muscle. The fuel necessarily consumed in causing the armatures of any machines to rotate, with sufficient rapidity, for its production, is much greater than is to be found in man, even were his muscular power equal to it. Perhaps the day may come when we can accumulate the energy or work of man, as we do when we wind up a watch, but even then the labour of one man for a week will be expended in a couple of hours. On economic grounds, therefore, steam or water power must be resorted to.

It would, at first sight, seem that by indefinitely increasing the number of revolutions, that is, by indefinitely increasing the amount of coal burnt in the furnace of the engine driving the machine, we might attain an infinitely intense light. Here, however, we are brought face to face with two facts which must cause a limitation; firstly, the intensity of the light must be dependent on the amount of magnetism of which the coils are capable of holding; and secondly, it is limited by a physical principle which has hitherto, perhaps, not been sufficiently recognised, viz., that a great portion of the increased power given by increased consumption of fuel, goes to perform a different kind of work. It must be remembered that white light, as it is called, is merely a name expressing the combination of many coloured rays, some visible and a still greater proportion invisible, each of which is caused by its own distinctive tremor in the ethereal medium, and the waves of which have a fixed distance from crest to crest, lengths so small as to be measured only by the most delicate methods.

Taking the example of a magneto-electric machine that we have here, if the armature is caused to rotate at a comparatively low speed, the graphite, or metallic wire (which latter we have here) will remain black, though to the hand there will be a perception of heat. By causing the armature to rotate more rapidly, we get a red heat, and by exercising still greater power we get a white heat or white light, which at last is so intense that we fuse the platinum wire. Now, if force were still further brought to bear, and we had used a graphite rod of small section, the light emitted would have a decided violet tinge. From this point a very large proportion of the extra work the engine might be called upon to perform would go to produce the shortest waves of light which are imperceptible to the eye, excepting by an artifice; hence the extra expenditure of fuel is to a certain extent unproductive for the purpose required. In other words, more fuel is required to produce the ultra-violet rays than to produce the violet, and the violet than the blue, and the blue than the green, and so on. It must also be recollected that the coils of wire round the machine are really part of the lamp, and that work is expended in heating them by magnetisa-

tion and demagnetisation in the same way as it was expended in heating the platinum wire. In one case, of which I am cognisant, a magneto-electric machine was worked at such an immense speed, that on dismantling it the wires were found carbonized, and consequently it was spoilt, though the light produced was no better than when a less speed was adopted. It may then be taken as a fact that the brilliancy of light a machine is capable of producing, is dependent on the weight of judiciously-placed iron. From some recent experiments which I was called upon to undertake, abundant proof was furnished that the violet and ultra-violet rays of the spectrum were largely increased compared to the other rays, when a machine was driven at a high speed. It is doubtless well known to all, that chloride of silver is sensitive to certain coloured rays (shown by a darkening action), but that by the rays extending from the green to the red it remains unchanged. If then the optical and also the photographic values of the light be measured and it be found that with increased speed the photographic value increases at a higher rate than the optical, we should be certain that the higher rays had increased proportionably more than the lower ones. The instrument, which I have called a diaphanometer, employed in these experiments for finding the optical value of the light is that shown. The light to be measured is reduced to the same intensity as a standard wax candle, burning 130 grains per hour, by means of a black wedge. The amount of light cut off at each part of the wedge is calculated, and from a formula, the intensity of the illuminating power of the electric light is known. The photographic value of the light was obtained by placing strips of uniformly sensitive paper, at a

Fig. 4. Fig. 5.

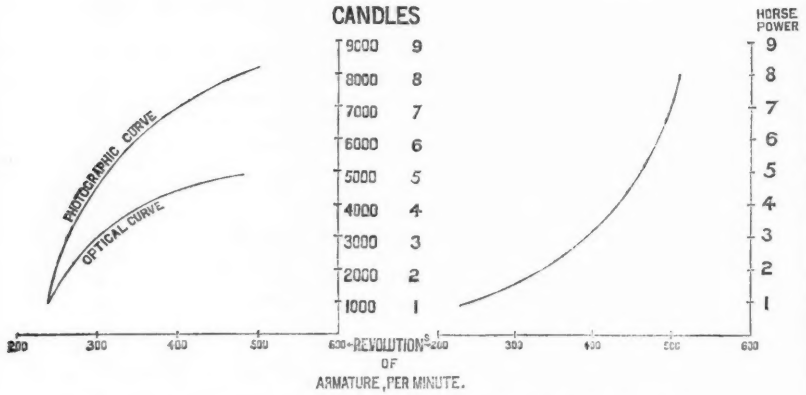


Fig. 4 shows the relative values obtained by photography and that by the eye.
Fig. 5 shows the horse-power consumed in causing the different number of revolutions of the armature per minute.

constant distance from the points, beneath a thin graduated wedge (together with others unshaded), and allowing them to be acted upon by the light for a fixed period. A comparison with a tint produced by sun-light as a standard, enabled a comparative photographic value of the light to be formed for each number of revolutions of the armature. The curves shown, give the photographic and the optical values of a machine driven at varying speeds. As before announced, the conclusion to be deduced from these curves is, that for each machine there is a certain limit to the useful work that can be drawn from an engine. With an average machine, it seems that when working to this limit, one-horse power is equivalent to about 800 candles, an equation which can be turned into the amount of coal necessary to be consumed per hour for the production of a certain intensity of light.

Here we have an example of a comparatively large quantity of low heat produced beneath the boiler of the engine converted into a small quantity of intense heat (sufficient to melt platinum, the most infusible of metals), with the accompaniment of an intense light. In both cases, the heat taken up by a theoretically perfect engine, and the amount it gives out, are equal, though the quality and intensity of the heats vary.

A stationary magneto-electric machine, which seems suitable for military purposes, weighs about 17 cwt., and requires an engine of about 6-horse power to drive it. No doubt the apparatus for generating light by voltaic electricity is the more portable, but it gives less brilliancy and is more easily put out of order: 12 hours' work can easily be got out of the former, whilst it is doubtful if even a fair light would be kept up continuously for three hours with the latter.

We now come to the value of the light for illuminating purposes. It has been calculated that each mile of dry air abstracts by dispersion (caused by the reflection of particles held in suspension) about 5 per cent. of the brightness of the light.

In general, the formula expressing this absorption is,

$$B_1 = B_0 E^{-mx}.$$

When B_1 is the brightness to be found, B_0 the initial brightness, m the co-efficient of absorption, and x the distance through which the light travels.

Thus at the end of one mile, with 5 per cent. absorption,

$$B_1 = \cdot 95\ B_0,$$

at the end of two miles,

$$B_1 = (\cdot 95)^2 B_0,$$

and so on.

The brightness, however, is only a factor of the illuminating power, though for signalling purposes it is the principal effective.

Suppose we call this last I. Then I, diminishes as the square of the distance, because the same light has to illuminate a larger area.

The formula is,

$$I = \frac{B_0 E^{-mx}}{x^2}.$$

From the foregoing figures it may be believed that the brightness diminishes very slowly, and that for military or for naval purposes, the diminution need not be taken into account. This is, however, not the case, for when the atmosphere is hazy a very much larger percentage than 5 is cut off, and as a rule, amongst the parts chiefly absorbed are the most luminous rays, viz., the yellow and green. In moderately foggy weather the brightness of the light at half a mile is often reduced 90 per cent., whilst at a mile it would then only have $\frac{1}{100}$th of its original value, and the light absolutely reaching the spot would be of a decidedly red tint; an ordinary example of the absorption of the rays of white light is the light of the sun's disc seen through a London fog. Aqueous vapour absorbs nearly all the ultra violet rays, diminishes the blue rays, but leaves certain of the red rays nearly intact; from this we may deduce that a red light can be seen farther in misty weather than a yellow, green, or blue light. If possible, then, it should be arranged that the light should be of as red a character as possible, not by the interposition of red glasses, or other red media, for they only accomplish what a fog itself would do, viz., cut off the most luminous rays; but the absolute light itself should be reddish, that is its component rays should have as long wave-lengths as possible. Now there are two ways of accomplishing this; 1st, instead of having one lamp giving a very intense light composed of rays of a proportionably high number of short wave-lengths, we may use the same power and produce two or more lights, which taken together, are richer in the longer wave-lengths than in the smaller. A glance at Fig. 4 will show that this is possible. 2ndly, instead of pure carbon points, we may use a combination of carbon with metals which, when volatilized, shall produce a red light. Amongst these metals are calcium, strontium, and lithium. They are very expensive as metals, but in combination with non-metals, such as chlorine, they are cheaply procurable in commerce. Some experiments undertaken at Chatham have been of such an encouraging nature that I hope this method of attaining the desired end may be practicable.

On the screen is now thrown the light produced by incandescent carbon and volatilized calcium. The tint is of a red colour, and when a ray is passed through a prism and allowed again to fall on the screen, the spectrum is at once seen to be richer in red rays than in the more refrangible. A similar effect is produced when we employ strontium or lithium with the carbons.

The illuminating power of the most powerful magneto-electric machine that I have seen is equal to about 11,000 candles. Sunlight itself is equal to about 5,000 candles, concentrated at a distance of 3 feet from the object. At the sun's distance, to give the same light as *he* does, would require 130×10^{24} candles, supposing no atmosphere intervened between us and him.

On the supposition that no brightness of the light were lost through impurities existing in the air, at a distance of half a mile a machine giving a light equal to 5,000 candles, could have an illuminating power equal to $\frac{1}{100}$th of a candle held a yard off an object. If,

however, only half the sphere of the light could be condensed into a beam having angular dimensions of $15° \times 5°$, the light would be intensified 100 times, or would be about equal to a candle shining on an object at a distance of four feet, a light evidently quite strong enough to be of use. At a mile, the light would be equal to one candle at 16 feet distance, which would be still fairly efficient, particularly when an observer collects greater intensity by using field glasses.

Perhaps I ought to explain why it is suggested to condense the beam into $15° \times 5°$; 5° is quite sufficient *depth* of beam to illuminate any depth of area from a moderate height—that is, in a direction *away* from the light, whilst it seems insufficient to illuminate a proper width of area. Some lanterns are constructed to throw a beam of only $2\frac{1}{2}°$ in width. There is more concentration of light, but the smallness of the angle subtended at the eye by the illuminated portion prevents a certain requisite distinctness. Also in sweeping an area to discover an attacking force or boats, the chances are that with a 15° light they will be more readily picked up than with a $2\frac{1}{2}°$ light, as the time which it would rest on any one spot, would be nearly six times with the former as compared with the latter.

A larger angle than 15° is not advisable, as then the effective light rapidly diminishes in intensity. I may also remark that the beam of light is always more intense at the centre than at the margins, which seems advantageous in some respects.

I have already referred to red light as being the most penetrative in hazy weather. It has also another advantage, which strikes me of importance. *Form* can be more readily distinguished by a red or a blue light than by white. This is not an observation which is a merely personal one; on one occasion a large number of gentlemen attended an exhibition of the powers of a machine, and all noticed the same fact. It admits, I think, of explanation in this way: supposing an object illuminated with 64 units of white light, and another next to it with only 1 unit; this latter will not find a place on the retina, but will appear dark. Now, with the electric light those objects which happen to be in the direct path of the beam only receive illumination by reflection from adjacent objects; or if at a very obtuse angle with the beam, receive only a very limited portion of light. It can rarely happen that the reflected light is equal to $\frac{1}{64}$th of the direct light; therefore, these reflecting objects remain unseen. With red light, experiment has convinced me, that a much larger difference in intensities can be appreciated; hence with it the form of an object can be more readily grasped.

Whether the similar effect produced by blue rays can be explained in the same manner I do not know, as no experiments have been undertaken to ascertain it.

The fact remains, and whether the explanation be satisfactory or not, it may be worthy of consideration when the light is employed for naval or military purposes. A piece of blue or red glass placed in the path of the rays will be effectual, if it does not cut off too much light.

It may be useful to point out the conditions under which an illumi-

nated area of land or sea can be most favourably watched. It is a matter of remark that most people naturally choose a position close to the source of light, imagining that somehow they thereby observe with an increased intensity of beam. This is a serious error, and one to be avoided. An observer (excepting in an unusual state of the atmosphere), should always stand away from the source of light. The most favourable position is naturally as close to the area as possible, but also nearly at an angle of 60° with the axis of the beam. An elevation of position is also a desideratum, for then full advantage of its depth as well as its breadth is obtained. The reason why a position at an angle with the axis of the beam is desirable is this, that where light is emitted from a point, the whole of the small particles of dust and vapour existing in the air (and which lie in its path) are strongly illuminated and reflect back light to the eye. The mistier the weather, the stronger the reflection will be. Throwing the beam of the electric light in the air of this room, its track is very perceptible to all. When we allow a little smoke to ascend through the rays the reflection becomes much strengthened. The particles of a mist, or of steam will evidently reflect much of the light, and there will be a consequent absorption and diminution of intensity after passing through an atmosphere charged with either. When standing near the lamp, the eye has to receive the illuminations of all those particles between it and the object, and if the latter be half a mile off, it can well be conceived that the effect is dazzling. Besides which, the eye cannot distinguish an intensity differing less than $\frac{1}{64}$th part. It might, therefore, happen that the light from the object and the particles would come within that limit.

When, however, the observer occupies the position indicated, it will be found that by taking the value of the light thrown back from the object and that from the reflecting particles, he obtains the maximum of distinctness of view. Though having a general knowledge of the effect of particles in the air when in the path of a beam, my attention was not particularly called to the subject till lately, when I attended some trials of different lights at Portsmouth. Boats were sent out whose supposed mission it was to grope for torpedo cables, and to cut them, in order to render submarine mines ineffective. On shore and in guard-boats observers were stationed to discover their approach. It was nearly invariably the case, I believe, that parties who occupied positions well out of the path of the light were the first to distinguish them, and generally it was some considerable time after, before those who were near the lamp could discern them.

As regards the attack on torpedo positions from the sea, it would be almost impossible to employ steam launches, as the white steam is always lighted up at very long distances, leading to the discovery of their whereabouts at once. Vessels may be constructed in which any escape of steam or smoke may be prevented, but at present such are rare. As a rule, I take it that ordinary boats, propelled by oars, will be employed.

From a position near the light, a black boat would naturally escape detection, but the faces of the rowers and the splash of the aërated

water thrown up by the oars would be very readily distinguished. Probably a crew with blackened faces and hands, using muffled black oars, might hope to approach unobserved from such a position, but from a point nearly at right angles to the beam, the illumination of the water would cause even a black object to stand out, particularly as a dark shadow must be cast by it. There are, doubtless, some present here to-night who can speak more authoritatively on this point than I can.

Another question arises which is this: supposing a boat to be observed, could guns be brought to bear upon it with any chance of success? It seems probable that they could. With a proper adjustment in the centre of the lens, there could be placed a small diaphragm, cutting off a small central portion of the beam. When this was caused to fall on the boat, its horizontal angular position with some fixed point and its angle of depression could be given by graduated arcs, and the sighting necessary to give the guns could be ascertained from a previously constructed table. The lamp itself under these circumstances would become a range-finder when its height above the level of the water is known. Whether this would answer better than ordinary methods is open to doubt; but I believe it would, as the object seen through an ordinary telescope would be not so easily found as when it can be found by the lamp itself.

As to the safety of the light when used to illuminate the sea, there is not much to be dreaded from enemy's guns. It would require an uncommonly good judge of brightness to distinguish the difference between the electric arc half a mile or a mile off, even when the normal value is known. As the intensity is variable, the chance of judging the distance is very small. If an enemy should be aware of the exact spot on which the light would be erected, he might have data on which to fix his measurements, but if the light could be moved only 200 or 300 yards, the chance of his *directly* striking the apparatus may be dismissed. The possibility of irreparable damage from shells might be avoided by the use of a couple of plane mirrors, with which to reflect the light from a safe position.

As to the shape the lamp should take, there are, I believe, diversities of opinion; but certainly, on theoretical grounds, the catadioptric form ought to be better than either the dioptric or catoptric.

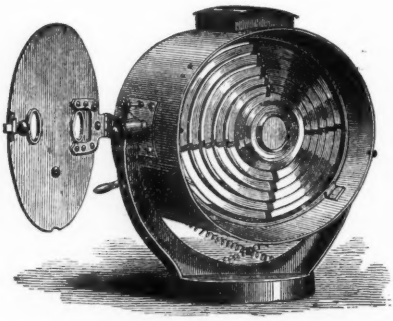
In the dioptric system, when no reflectors are employed, a large quantity of side and back light is lost.

In the catoptric system, where reflectors are used, it has been calculated that two-thirds or three-fourths of the light is wasted, being dispersed in directions not required, unless a complicated system of auxiliary mirrors be adopted. Again, metal, of which most parabolic reflectors are made, also causes a great loss of light, due to the hammering which it undergoes.

In the catadioptric system, both reflection and refraction are utilized; and when the reflectors are formed of glass, the waste of light is minimised. Fig. VI represents a lantern which has been actually employed in military experiments. The catadioptric system is also now feasible; as by the method, introduced, I believe, by Chance

Brothers, of Birmingham, glass rings of accurate section, both for lens and reflector, can be made of the most effective nature. It will be noticed, that the principle of total reflection would be adopted in the reflector; and unless the angle of reflection be much greater than a

Fig. 6. Fig. 7.



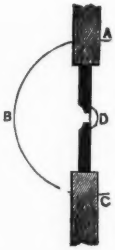


Fig. 6 shows the section of the spherical reflector, the centre of the electric arc being the centre of the sphere.
Fig. 7 shows the lens of the lantern in perspective.

right angle, there will be no appreciable loss by prismatic dispersion. In every case, whatever may be the form adopted, the lamp should be capable of revolving round a vertical axis, and also of depressing or elevating the beam.

To test a lamp, the eye should be placed where the electric arc will be produced, and every point of the area should be distinct through the lens, showing that the rays converge properly from the position on which the light will be cast. The lamp, in fact, becomes a camera-obscura, with one huge objective. This mode of testing was first suggested by the Astronomer Royal, whose theoretical researches on light have gone far towards causing the present improvements in all kinds of optical instruments.

We, of the Services, are morally bound to employ any agency which will be effective in prolonging a defence or in shortening an attack; and it seems to me, that in the magneto-electric light we have a weapon placed in our hands which we shall eventually be compelled to adopt. The time when night attacks are to be dreaded as much as they are to be now, must pass away with the introduction of a means of illuminating an area round a fortress or an entrenchment. The value of a gun must be much enhanced when it can be rendered nearly always effective; and I look upon it, that the time is not far distant when an armament will not be complete unless it has a means of being employed with advantage at night. I do not believe that we have at present the very best form of light, any more than I believe that we have a perfect gun; but it strikes me that the former is so far advanced

in effectiveness that it should be rendered a necessary adjunct to any fortress and force.

In our telegraph train, the army has naturalized one form of electricity, and before many years have passed, I believe, it *must* adopt that form which I have endeavoured to demonstrate to you to-night.

The day has passed when the Services can afford to put inventions under their pillows, and sleep upon them; they must be always awake to the progress that science makes, and be ready to adopt and adapt any discovery which will help them onwards towards perfection.

The CHAIRMAN: I must say that we are all very much indebted to you for the information you have given us on this subject. Of course, we understand that there are points which you cannot go into, namely, such matters as have been under your consideration on behalf of the Government; but I am happy that you have been able to give us so much information which does not in any way trench upon your position with the Government, and we are very much gratified by it, and thank you sincerely for it.

SPECIAL LECTURE.

Monday, February 14, 1876.

GENERAL LORD SANDHURST, G.C.B., in the Chair.

"THE TURKISH FORCES," AND "THE MILITARY ASPECTS OF THE EASTERN QUESTION."

By C. E. HOWARD VINCENT, Esq., F.R.G.S., Lieutenant-Colonel Central London Rifle Rangers, and of the Inner Temple, Barrister-at-Law (late 23rd Royal Welsh Fusiliers).

YOU have come here, Gentlemen, this afternoon to hear a lecture on a most interesting and important matter. It would be scarcely too much to designate it as the most prominent subject of the hour. For twenty years it has slept upon the blood and treasure expended in its solution, but to-day it is here presenting greater difficulty, greater confusion, a more dismal future than ever. After what has fallen from the Chairman I make no apology for having responded to the wish that I should summarise for the members of this Institution my recent studies in the Ottoman dominions and the neighbouring countries. I would, however, crave again that indulgence which thrice before in this theatre you have been pleased to extend to me. I would seek it by reason of my own infirmity, by reason of the special difficulty of the task that lies before me. This, as you know, is no political arena, but rather a forum, to advance the knowledge of those sciences which pertain to the united services. Therefore have I to perform the somewhat delicate operation of dividing one portion of my researches from the other, of severing the military crust from the political substratum. I shall strive to keep wholly within the wise rules laid down by the Council; yet, lest I should even by insinuation overstep the line, I would observe that I alone am responsible for every word that I utter.

Gentlemen, I propose, as you will perceive, to divide my matter into two sections.

I. The Turkish Forces.

II. The Military Aspects of the Eastern Question.

I trust I shall not so weary you with the first as to lose your earnest attention for the second. But it appears to me that a mature exami-

nation of the Turkish forces must needs precede any accurate conception of the "The Military Aspects of the Eastern Question."

Without further prelude, then, I will pass in review before you the Army and the Navy of His Imperial Majesty the Emperor of the Ottomans. In doing so it behoves me before all to say, that whatever be the errors into which a defective education has led a strong and capable mind, however great the difficulties besetting eastern sovereign life, however fabulous, however true the personal narratives that penetrate the veil of its mystery, one thing is certain, that Abdul Aziz II, Sultan of Turkey, is an advanced and intelligent military reformer.

Into 120 military conscriptions are the Ottoman dominions divided, and nearly evenly among them are located the seven corps of which the Imperial Army is composed. Following exactly the northern model four units make up the total of national defence, viz. :—

(1.) The Standing Army, or Nizam.
(2.) The Reserve, or Ikdiat.
(3.) The Militia, Landwehr, or Redif.
(4.) The National Guard, Landsturm, or Mustafiz,—

representing, without the aid of the latter force, a paper strength of 750,000 men. Make no note, however, of these figures, nor of any indeed taken from Turkish sources which I may adduce. I frame my data from the concurrence of testimony, but cannot even thus hope to be near the mark. There is no doubt that it would be impossible to put more than half a million of Turks into the field.

(*a.*) The standing Army is recruited by conscription from the Mahommedan population of the Empire. Six times does the faithful Mussulman dive into the ballot-box. If in these six years the Nizam does not secure a recruit, the lucky one passes at once into the Redif. Such, though, cannot be the good fortune of the majority, and the conscript thus spells out his 20 years of service :—

4 years in the standing Army.
2 „ in the Reserve.
3 „ in the Redif (1st ban).
3 „ in the Redif (2nd ban).
8 „ in the Mustafiz.

The four years in the standing Army are usually reduced to three, or even two—a measure reducing battalion strength, but prudent alike on social and economical grounds.

Of the seven corps d'armée that I mentioned, three are stationed in Europe, at :—

(1.) Constantinople. (2.) Shumla.
(3.) Monastir.

and four in Asia, at :—

(4.) Erzeroum. (5.) Damascus.
(6.) Bagdad. (7.) Sanala.

Each corps consists of :—

7 regiments (28 battalions) of Infantry.
5 „ (30 squadrons) of Cavalry.
1 (84 guns) of Artillery,

with a theoretical strength of 27,000 men, which in war is supposed to be supplemented by 34 battalions of Redifs.

The first corps is frequently termed The Imperial Guard, and Yousouff Effendi, the eldest son of His Majesty, is the titular Commander. The men composing it are in a great measure selected from the whole Empire, for the inhabitants of the capital are exempted from service.

The Turkish infantry may be said to be without its superior in Europe as regards material. It consists of 49 regiments with four battalions of eight companies. The system of drill was devised by Hussein Avni Pasha, now Governor of Broussa, but under whose Grand Vizierate and Presidency at the Seraskeriat, the flood-gates of improvement opened on the country and the army. The rapidity with which the Osmanli soldiery move is extraordinary and unparalleled—compact independence, to which the neat yet easy uniform conduces. A fez, blue jacket and waistcoat trimmed with red, scarlet sash around the waist, trousers ample to the middle of the calf, then tight as a gaiter, and running into a soft boot of untanned leather. Such is the dress of gunner, trooper, and linesman.

The infantry is completely armed with breech-loading rifles—long Sniders, short Sniders, original, converted, of Tower pattern, of American make, Winchester's, Remington's, Peabody's—every system, I believe, that inventive genius has devised. Rifles, though, are not of themselves engines of destruction. They resent neglect and hard usage. Without cartridges they avail but little, and there is no machinery for issuing the complex ammunition required. In time the Henry-Martini rifles ordered from the Providence Tool Company will be supplied, and more uniformity insured.

The Ottoman cavalry consists of 35 regiments of six squadrons each, with a supposed complement of 100 men, armed for the most part with Winchester repeating carbine, sword, and pistol. At best, the cavalry partakes considerably of an irregular character. The men are good Oriental horsemen, but the Officers are no less untrained for field service than they are by nature unendowed with dash, energy, and spirit. The country is full of smart little horses, but there is no remounting system, and not unfrequently a fourth of the regiment is on foot, another fourth on worn-out screws ere a remount grant can be obtained. Of one regiment it is narrated that, reduced to a few score mounted men, the Colonel, after long solicitation, obtained the required sum. The season was winter. He thought that the fund placed at interest till the spring would then enable him to buy more animals. The Koran forbade such a scheme. In the regimental chest the sum was locked. There were long arrears of pay owing to the men, and an order came that the remount grant should be applied to defray them. The regiment of horse became a regiment of foot.

The Imperial artillery boasts of seven regiments and one in reserve. Each regiment is composed of three horse and nine field batteries of six guns. The former have four-pounders, the latter six. The whole of the guns are on Krupp's system and of his manufacture, with the exception of the six mountain guns made by Sir

Joseph Whitworth's firm, and the six mitrailleuses attached to each regiment. Not only has the whole of the artillery been provided with breech-loading cannon, but there are sufficient in store to re-arm every battery. As with the rifles, though, the feeding machinery has been neglected. The guns are there, but ammunition-waggons are to a great extent wanting.

The chief deficiency of the Turkish artillery lies, however, in the horses. The native animals are not adapted to the work, and the entire supply has to be drawn from Hungary. An annual commission is sent, and some good animals obtained at prices varying from £25 to £40. But it is on all sides agreed that the Hungarian horse is deficient in stamina, and in many eventualities it is obvious that even this market would be closed. The scarcity of draught horses becomes a more serious thing when the total absence of a transport corps is considered —in a country, moreover, where no levy on the inhabitants could produce any result. It is much to be hoped that some War Minister, remaining sufficiently long in office, will foresee the straits to which any serious campaign must reduce the Government, and take measures accordingly by founding breeding establishments for draught horses. Any surplus stock would meet with a ready sale.

There is likewise no regular engineer corps, as the state of the defences throughout the Empire only too clearly shows, and of course both pontoon and telegraph trains are wanting.

The Medical Department of the Army, on the other hand, is well organised. The School of Medicine at Pera is turning out excellent graduates—not enough, truly, at present for the requirements of the service, but in time the German surgeons now in the temporary employ of the Porte will be supplanted by Turkish practitioners. One alien alone will then remain, Dr. Temple, formerly of the 18th Royal Irish, attached to the 1st Regiment of Artillery, and Surgeon Extraordinary to his Majesty, exempt by Imperial mandate from the disqualifications of foreigners.

The military hospitals are numerous, well arranged, and beautifully kept. Close to the principal one at Scutari is the British cemetery, the resting-place of many a gallant soldier of the Queen. The care bestowed upon it by the guardian, Sergeant Lyne, late of the Royal Engineers, is beyond all praise. Strange is the contrast with the ruined graveyards of the Turks hard by.

The Officers of the Ottoman service now demand consideration. They form, with the exception of the surgeons, the weakest portion of the entire system. Ill trained from cradle to school, ill regulated from school to life's close, they possess, though perhaps not by their fault, few physical or moral virtues. Forced to discount their pay at ruinous rates, the majority live from hand to mouth, and military proficiency meets with but scant reward. The Staff hardly deserves the name, although some of its members receive a kind of special training, so small is it numerically; so weak, for the most part, intellectually; so indolent physically. With all this, it would be unbecoming in me not to make a grateful acknowledgment for the kindness with which, from the Minister downwards, I was treated. Without any official character

or recommendation, every consideration was shown me as an English traveller. Every Turk looks upon the Englishman as his natural ally. With Major Osman Bey, Aide-de-Camp to the Seraskier, and formerly Military Attaché at St. Petersburg, I visited every barrack, hospital, and military institution within reach of the capital; and everywhere, as previously on the Danube, I met with the same cordiality, the same friendly greeting, the same desire to show everything—to conceal nothing.

Nor must I omit to pay a just token to the Military Schools of the Empire. There are many exceedingly well regulated, and they form the peculiar pleasure of the Sultan. The shortcomings of Turkish officers are in no way traceable to any deficiency in the means of education. The schools are of two categories—primary, giving a general education, and receiving boys for four years between the ages of twelve and eighteen; secondary, receiving students under sixteen years of age, and after a four years course drafting them into the army. I visited a school of each character in detail, and many as now are the military colleges in Europe that I have visited, I never found a better system in any country.

The Auxiliary Forces are divided, as I said before, into three categories:—

(*a.*) The Reserve, or Ikdiat.

(*b.*) The Militia, or Redif.

(*c.*) The National Guard, or Mustafiz.

The Reserve is formed:—

(1.) Of those who have served four years in the standing Army.

(2.) Of those who have been released before the full period of their active service has expired:—

They belong to it until the completion of the sixth year of their enrolment under the Crescent. Arms for the Reserve of each battalion are kept at head-quarters; clothing and accoutrements likewise. In theory the reserve men on the outbreak of war revert to their original corps. But, owing partly to the absence of all methodical civil administration, partly to the imperfect means of communication, there is no possibility of the principle being enforced. Last autumn showed the truth of this statement. The reserve men are seized by the first regiment they meet. Were it otherwise, in the words of Colonel Zelinoi, the able and indefatigable Military Attaché to the Russian Embassy, they would never reach the theatre of operations. It is obvious that such a system is in the highest degree injurious to sound organisation. One battalion takes the field 300 strong, another with more than double the number.

The Militia, or Redif, consists of:—

(1.) Those who have escaped the conscription.

(2.) Those who have completed their term of service in the Nizam and the Reserve:—

The period of service is twelve years—the first three, theoretically, in the senior battalion, the second three in the junior battalion. But, with very few exceptions, this second battalion has no real existence. The officers of the Redif form a permanent institution in the proportion of

two to each company, and one field officer per battalion. They should receive the same pay as those of the standing Army, and cannot be much inferior to them in intelligence!

For a month in each year the Redif is called out for training. Not the whole battalion—the six contingents in the absence of the second forming but one—only four-sixths thereof. The Militiaman consequently in the course of his six years' service in the force goes through four trainings.

I was afforded the opportunity in the vicinity of Constantinople of closely inspecting a Redif brigade. It consisted of two battalions, come the previous day from Asia Minor, leaving that evening for the Herzegovina—eight companies of 100 men, splendid fellows. Called out in mid-harvest from a district depopulated by famine, for a cause in which they took no interest, discontent might well be expected to prevail. Never, though, was the Padishah more enthusiastically saluted than by those 1,600 voices. One could but feel that with such men any difficulty might be surmounted. But who was to lead the way? One officer, of wretched mien, to each of those strong companies. What mechanical force was there to support the physical? Long rifles and scabbardless bayonets in the case of one battalion, short rifles and swords in the case of the other. Uniformity alone in the dirty, utterly unserviceable state of the weapons.

As to the last unit in the auxiliary forces—the National Guard or Mustafiz—it is the very embodiment of theory. It boasts neither organization nor arms, nor officers, nor cadres save in misrepresentations to the greatest autocrat, the most deluded monarch of the civilized world.

Now as to the Imperial Navy—it consists of twenty-six ironclads, embracing every description of battery, but with, I understand, too thin plating for these days. The Officers are *au complet*. The men about half. How far either the former or the latter are fit for sea, I will not presume to opine. Practice in navigation they certainly never have. All the year round this glorious fleet lies in idle state in front of the imperial palace. The Sultan gazes thereon from the presence-room of Dolma Bagtshé, and believes when he is told that he rules the world. There are none in "his" service who will undeceive him. He knows no foreign language, and the Turkish prints are under the censor. Financial difficulties are unknown: dreams of troubles to come do not disturb the Imperial slumber.

The men of the Army and Navy now have to be considered. Of them as individuals it is difficult to speak in exaggerated terms. Whether of the standing Army, of the auxiliary forces, or of the Navy; whether of the capital or in the provinces; whether in garrison or in the field, these tall, robust men have no thought save that of duty and implicit obedience. Wretched, deplorably wretched, as is the controlling force, crime is so rare that there is no regular scale of punishment. Every order is executed to the very letter. Long arrears of pay produce no grumbling. Drunkenness, absence, desertion, are well nigh unknown. In short, to quote that distinguished officer, Admiral Hobart Pasha, Inspector-General of the Imperial

Navy, they are the finest men in the world—hardy, brave, active, intelligent, patient, enduring, submissive, obedient, beyond comparison.

Thus do I complete my review of the Turkish forces. I presume to hope that I have succeeded in showing what splendid material they contain. Nor have I sought to gloss over their numerous shortcomings. The men are admirable, but the officers very imperfect. The guns are numerous, but there are no horses to drag them. The rifles are of the best type, and enough of them to give one to each Mussulman in Stamboul, but there are no cartridges. Truly the engines are ready but there is no motive power. The ally of Turkey will have to supply it. Officers, horses, waggons, ammunition, method must be provided before the Turkish forces are really fitted for European service. The proof of this is, I fear, to be seen in the operations still pending in the Herzegovina. Not one of the defects which I have enumerated but is there felt, and none more so than the continual change in the chief command, and consequent reversal of plans. Yet it is also positive that the moral support afforded to the insurgents by the three Emperors, and probably the pecuniary aid furnished by one of them, has a very great deal to do with the protracted nature of the struggle. It cannot, however, long continue, and it is much to be hoped that so soon as peace has been restored, some energetic Pasha (and none better than the deservedly popular Hussein Avni, the soldier-vizier) will be placed and maintained at the head of the Army, and energetically complete the building, of which so fine a foundation exists. The carrying out of the 23rd Article of the celebrated Khaththy Humaïoun, by the admission of Christians into the Army on the principle of general equality, would facilitate the all-important infusion of foreign superior element, would free the country from much of the burden and depopulating consequences of the conscription, and then the Turks will take a high place in the European military family.

The Military aspects of the Eastern Question.

Now, Gentlemen, I solicit your most earnest attention. We have done with statistics, and it remains for us to consider what military changes twenty years have wrought in the *bête noire* of modern politics. First of all, what is the Eastern Question? There are probably none here, but there are many outside who totally misapprehend it. To some it imports the maintenance of British Empire in the east. In the minds of some it is vaguely connected with religious questions—the tyranny of Mahommedan over Christian, the ownership of a silver cross at Jerusalem. Not a few either are there to whom it has no meaning, who have never sought to present it to their minds in a clear and definite form. Before them I would thus put the Eastern Question, "*Whether Turkey in Europe must be maintained intact?*" It is positively this, nothing more and nothing less. You well know that I am not here to uphold the merits of the affirmative, or the negative answer. But it is obvious that if all the European Powers interested therein were agreed upon the point, there would be no Eastern Question at all. Therefore it is clear that as there is a

decided Eastern Question, the interests of some States point to one solution, of other States to another. Without defendants there could be no litigation, without aggressors there could be no war. It will not consequently be foreign to my *rôle* to inquire without prejudice, first, what Powers are interested in the Eastern Question? and, secondly, how do they severally view it?

Historical recollection and geographical knowledge will lead you to a ready answer. The greatest statesmen of times gone by, the eminent names in British story, regarded it in a positive light. Frederick the Great, Napoleon, Talleyrand, and Metternich; Chatham, Pitt, Wellington, Canning, and Palmerston were all agreed upon the subject. During the present reign we have undertaken a long, a costly, and a sanguinary war to uphold the integrity of the Ottoman Empire. Is that integrity still of interest to us? Nothing has to my knowledge occurred to render it otherwise. In it we still, with Turkey, Austria, and France, are primarily interested. In it Germany, Italy, Greece, and Spain are much, though perhaps secondarily, concerned.

But have I not omitted from this enumeration of nations one great state—the mighty empire which stretches from Vistula to Volga, and even further into Asiatic desert, from White Sea to Black—Holy Russia? Can this be on account of her indifference? No. The Eastern Question is of greater importance to Russia than to all the other countries put together. Is it viewed at St. Petersburg according to what I may call the aggressive and expulsive, or the defensive and retentive theory? I will not here presume to say. Vast as is the area over which the commands of the Romanoff are obeyed, it is clear on the face of things that the material welfare of the Empire requires a surer, a safer, a more accessible maritime exit than is at present possessed. More than once, in this theatre and elsewhere, have I dwelt upon this cardinal point in the faith of every Russian. More than once have I craved observation for the question we are this afternoon considering—have thrust forward its claims to attention in preference to that most mythical, that most unfounded, yet, for some, that most absorbing belief in Russian designs upon India. Her traditional ambition, her obligatory ambition, her true ambition is wholly and solely directed to securing a passage, safe in peace, safe in war, from the Euxine to the Mediterranean. So let it be, and a new rival enters upon those waters. Judge for yourselves, Gentlemen, what existing interests will be thereby endangered or promoted.

But let us see how in a military sense—and I will take that adjective to comprise naval—the Powers named are situated as regards a definite solution of the Eastern Question.

First of all, as to Turkey herself. You have had her land and sea forces arrayed, feebly though it may be, before you. I concerned myself solely with the fez-bearing, but add thereto now the armies of Roumania and Servia. Both are vassal by name, vassal by tribute, to an indulgent, never interfering Suzerain. Roumania, with a Teuton Prince at the head of affairs, has a Prussianized army. Every day adds to its efficiency. Sixty thousand men, or thereabouts, it numbers, and these, if set in motion by the national feeling, alone are ready to main-

tain the secure and guaranteed position, the practical independence and prosperity the Principalities now enjoy. I do not say that the Porte can absolutely count upon this armed assistance. The favour lately shown to prominent Roumanians by a neighbouring sovereign, the fluctuations of power, may endanger it; but certain it is, that the match that fires the smouldering flame will with its first spark change the military tenure of the territory lying between the Pruth and the Danube.

Servia we must regard with different eyes. The ruined battlements of Belgrade perpetually remind the otherwise unemployed inhabitants of the late Moslem occupation; yet Turkish rule is no more actively felt than in Roumania. It is only the capital, not the ignorant, thrifty population of the interior, that seeks to break asunder from the light Osmanli yoke. Nor is the enmity unallied with Sclavonic sympathy; yet there exists but a sorry army, large on paper—90,000, I believe—but of little real value. It possesses few officers, few rifles, fewer guns, and less organization. But over a restless people, Prince Milan Obrenowics anxiously holds his sceptre, while the rival Karageorgevics awaits, five leagues distant, for a change in the halting and whimsical affection of Belgrade and the Skuptschina.

Now it is apparent that, if in that, let us hope, remote contingency, Russia seeks to move by land, on the Ottoman Dominions, the first step must be the occupation of the flat Roumanian lands. Such might not be difficult, but beyond there lies the broad and rapid stream, des Schönen blauen Donau. West to east it runs; northern bank flat, open, and well adapted for armed manœuvre, commanded, though, by position succeeding position on the southern shore. An able Captain, with an active, intelligent force of cavalry, who chose his positions carefully, would long defend the fluvial passage. His centre would rest on Rustchuk, and either wing on Widdin and Silistria. Of them, though, anon. When at length the passage was forced, the Turkish troops would fall back by Shumla, on the Balkan range. The position of Shumla alone would not be overcome without difficulty, and then the invaders, weakened by their Army of occupation in Roumania, by the crossing of the Danube, by the corps detached to mask Widdin, Rustchuk, Silistria, and Varna, would find a very serious barrier in the passes and defiles of the Balkan.

But if the double-headed Eagle elect to make a feint only on the northern frontier, and to leave for subsequent subjugation the fortresses on that quarter, choosing rather for the real attack to make a sudden dash on the capital by sea and land, there would be much to recommend such a course. Disembarking fifty thousand men in the undefended Gulf of Bourgas, the fate of Stamboul might be a question of days. Do you know the Bosphorus, that narrow passage, with swift and treacherous current possibly, but yet with water so deep, that a vessel of the largest draught may anchor almost within a stone's throw of the shore? On either side crest succeeds crest. Each offers an artillery position. Fortified and defended, a forced passage would be almost impossible, but what is the state of the case? An indifferent work is to be seen on the Asiatic coast,

nothing besides. The depth is too great for torpedoes. How it is that the Turkish Chief of the Staff devotes his talents, his energies, his resources to the erection of barrack and store house upon barrack and store house, while the heights of the Bosphorus, the only landing place on the Black Sea coast, are undefended, while Varna is ill-guarded, Silistria is left in its ruined state, while Rustchuk falls into disrepair, while Widdin and Nisch are scarcely worthy of the name of fortresses, is for him to explain.

The Russian Fleet would co-operate to some extent with the land forces. I take it to be very uncertain how much work is going on in the dockyards of Nicolaïeff; but from such sources of information as are at my command, I am justified in assuming that the Black Sea Fleet is sufficiently strong to protect an embarkation at the point I have indicated. Whether it be absolutely a match for the Turkish ironclads is very doubtful; but you will perceive that I consider this plan in the light of a *coup de main*, rather than in that of a campaign of which the defenders and their allies have had long warning. Russia possesses such extraordinary facilities for concentrating troops and material of war without attracting attention, that she would probably find it easy to drop upon the Turk unawares. *I* doubt even if three ironclads could leave their moorings in the Bosphorus for a few days' cruize without a month of preparation.

Let us now see what light Great Britain could shed upon the matter. Recent events have not materially altered the position of affairs. The Eastern Question is indeed connected with our road to India. But think not that this road is solely one for the conveyance of our troops, for the passage of our ships. The road to India means, indeed, one for the transit of men and merchandize, and also one to the hearts, to the loyalty, to the submission of the vast Mahommedan population to the Supreme Power. This loyalty, this submission, depends much—those who have been in India know how much—on the alliance of the Queen's Most Excellent Majesty with the Caliph of the Prophet, the Sultan of Turkey. I have before shown you how obedient to rulers of this creed is the Mahommedan soldier, and even so is the Mahommedan layman. The infringement of religious precept could alone break through this rule.

Nor are the new rights so patriotically acquired over the Suez Canal, any positive assurance that the material road to India will be for ever secure. So narrow, so shifting, so difficult is the passage that even in time of peace the speed of four knots an hour must not be exceeded. Often and often a vessel runs a-ground. The treacherous sand is here to-day and there to-morrow. The buoys which yesterday marked the course have now to be moved. I am informed, credibly informed, that a single boat in a single night is capable of stopping all safe navigation through the Canal; and will not the able and renowned Officer, who, if report runs aright, is entrusted by leave of his Tsar, with the portfolio of war at Cairo, see that land defences guard the waterway? In short, be not surprised, if, on some future day, the existence of a Treaty, that you now little dream of, is brought to light.

Do you, then, go with me in the theory that Great Britain is pre-eminently interested in the great question before us? The preservation of Turkey is closely connected with our own highest interests. How do we, then, stand as regards the question in a military aspect? As matters are, I very much doubt if any active interference would have such a reasonable chance of success as to justify its being attempted. The Army which is available for continental operations is too small to render any vast assistance, unless everything be prepared, everything favourable, to the execution of a fixed and definite plan. It might be otherwise, were the Militia liable for foreign-service in time of war; a practicable scheme I mentioned here last summer. But we can only take things as they exist. On any attempted rupture of the present *status quo*, it is probable that our Mediterranean Fleet would be despatched to the Dardanelles. A large portion of the garrisons of Malta and Gibraltar would be moved at once eastwards. Within ten days forty thousand regular troops would be despatched from our shores, and ten days later might disembark on Turkish soil, *i.e.*, at least three weeks after the declaration of war. Remember that, until that declaration, we could not move a man, for such movement would assuredly constitute a *casus belli* of itself. Three weeks in this age is a long time, and, as you will have gathered, my deliberate opinion is that the Turks do not at this hour possess the means of resisting any skillfully planned and energetically conducted invasion. They will not submit quietly,—a St. Bartholemew's day might recur,—but I do not think that any firm stand could be made, reasonable chances favouring both sides. Nor is this all. Any British Army sent to assist Turkey, to uphold our policy of ages, and from which it would be fatal to depart, would meet with every obstacle long before it came face to face with the aggressor. Nearly everything would have to be furnished from the Fleet, for in such a state is the country that it is almost deprived of the usual means of sustenance. The entire transport would have to be provided. At home, even the service is defective. How, then, would it be possible for us to establish it, within the required time, ready for an arduous campaign, thousands of miles away? Horses, again, we should have to send. Have we them here? Can we have them there? Then, also, engineer and pontoon trains, to say nothing of ammunition.

This is now the state of affairs. But let us hope it will improve. If, say a million sterling were spent now in fortifying the Bosphorus, Bourgas, Varna, and the line of the Danube; in organising transport; in providing horses; it might save many millions to the British taxpayer hereafter. If Officers be sent, or at least encouraged, to go and learn Turkish, to instruct the troops, to stimulate the Navy, then British arms will be able successfully to co-operate with Turkish battalions. One other matter, too, is all important, whether with or without English interference, viz., the completion of the strategical railway from Adrianople to Shumla. Three years ago was the contract signed by Baron Hirsch, on the one part, and the Turkish Government on the other, but intrigue has successfully postponed the carrying out of the work. Without that line, I do not see how troops

could be moved up to the Danube—how they could be supplied with field equipment. It would bear, too, with the utmost importance on any assistance we or any State gave to the Sultan. Its immediate construction ought therefore, I submit, to be insisted upon *coute que coute.*

The position of Austria, as regards the Eastern Question, now demands consideration. Any encroachment of Sclavonic power might inconvenience her in the highest degree. Despite the recent Note, despite any temporary uncertainty in her views, I cannot but think that my query must be answered in the affirmative at Vienna. Already overburdened with heterogeneous races, it cannot be that the House of Hapsburg seeks to bring more turbulent tribes and greater discordance into its midst. I refer to the acquisition of sovereign rights over the Ottoman Provinces now the subject of so much concern. Everything points to a firm accord between the Cabinets of St. James and Vienna, on Eastern Affairs, and this has an important bearing on the military aspects of the question. Even without Great Britain, any active support afforded by Austria to Turkey must materially change the plans of attack. Moving, as her troops would do, on the invader's flank, the northern Army of offence would have to be one of surpassing magnitude, for I entertain doubts as to the reception that the Muscovite would meet with in Roumania, if that excitable population was influenced by the approach of Austrian succour. In a very few days, 300,000 Austrians might man the Danube. To Bazias there is perfect railway communication, and the vast fleet of river steamers is entirely in the hands of the Viennese Government. Austria is consequently able to send the maximum aid to the declining Ottoman, and if co-operating with England, as I trust she would, any attempt to dismember the Turkish Empire would meet with summary punishment.

Time was, and a very short time back, that another State would have claimed a positive right to be consulted on any reappearance of the question of to-day. But for the present, that time has gone. The influence which, not long ago, was paramount at the Sublime Porte has completely faded. There are many present who well remember how gallantly the French fought side by side with them on this very matter. How the Anglo-Franco Turkish alliance silenced the questioner is matter of history. But now, France will assuredly not interfere actively in any solution of the Eastern problem that may arise. The Russian alliance is the first consideration. It may cost much, but to Gaul it is worth anything, and of that every Frenchman is convinced. France, then, has ceased to influence the military aspect of the question.

Even so with Germany. On the other side of Whitehall, it was authoritatively said, I believe, and not so very long ago, "The Eastern Questern is for Germany a matter of purely secondary interest." This too is obvious. The German interests in Turkey are very small. Those in Russian friendship enormous, no less so than to France. Teuton intervention in any Russian mode of breaking in upon the situation, means for Germany a double war, each requiring all the force, military and civil, of the nation; for France rehabilitation, and

victory. Close by me, though, is an Officer who, the other day, told me with serious face that all had been prepared in that terrible "general stab" for the invasion of Britain, the annihilation of France, the subjugation of Russia, all at one and the same time. I trust my friend will survive so appalling an idea, and live to see that the new Empire is and must be peace, until the inevitable war of revenge has been reckoned among the horrors of the past.

I need not detain you with any analysis of the aid Italy, Greece, or Spain might bring to the question. Highly improbable is it, indeed, that they would do aught in a military war, but to each of them the present condition of things is most favourable to their prosperity. To Greece, through which I have lately travelled, is this especially the case. So is it viewed by every Athenian of intelligence. But, mentioning Greece, I cannot refrain from inviting attention to a scheme projected by the ancients, but, owing to scarcity of funds and local disturbanees, never carried out—the piercing of the narrow Isthmus of Corinth, the junction of classic Ægean with Ionian Sea. To Austria, to Italy, it would be of vast benefit. The dangerous doubling of Cape Matapan would be avoided; and, in a military sense as regards the Eastern question, and in a commercial sense, such an undertaking recommends itself to politicians and financiers.

Gentlemen, I have done. I trust I have not over-taxed your patience, nor said aught upon which any erroneous construction could be placed. I am grateful for your attention. But, in conclusion, let me beseech you not to let your investigations end at the point to which I have presumed to carry them. Consider the Eastern Question well in its magnitude, in its importance to our beloved country. Consider it well, not in any sophistical aspect, but in its true bearing to British interests. The solution will then be left to time, and even, I may say, to another generation.

LECTURE.

Friday, May 12, 1876.

MAJOR-GENERAL SIR GARNET J. WOLSELEY, K.C.B., G.C.M.G., &c., &c., &c., in the Chair.

THE ITALIAN ARMY.

By Colonel the Right Honourable Lord WAVENEY, F.R.S., A.D.C. to the Queen.

IN the address that I shall have the honour to give you this day, I am perfectly aware there exist very considerable difficulties, that the task is a very heavy one, but it is so intimately connected with the subject that closely engages our attention at present, namely, the re-organization of the Armies of Europe, and also is so conjoined with the fortunes of that great country, the Peninsula of Italy, over the progress of which we have watched with much anxiety, that even at the risk of giving a very incommensurate and insufficient idea of the circumstances which may be more plain to me in my imagination than I may be fortunate enough to make clear, I am still disposed to undertake the task. I had hoped, indeed, that on this occasion one of the old soldiers of the long series of successful and unwearied struggles which I shall now have to relate to you might have been present. His Excellency the Italian Ambassador, had he not felt the paramount duty of attending the Court of Her Most Gracious Majesty, would have been present on this occasion, and thus I should have had the advantage of that enlightened and personal criticism which would have corrected the errors that I must needs, I fear, fall into.

The subject we treat this day is not one of the mere organization of the military force, but is so interwoven with the history of the country generally, with its improvement and defence, that you will permit me, I trust, to refer to some historical points before I proceed to the question of military organization. After the close of the Napoleonic struggle, one dead level of repose settled down upon Italy, made heavier and more grievous to her people by the political incapacities that restrained the exercise of constitutional rights. With the exception of one small State in which free action, both as regards the

people and as regards their government, was kept alive; with that exception, all the rest were held in a bondage the more hateful, that it was maintained by foreign bayonets. It is difficult to procure any map of Italy which sets forth very clearly the position which the small Duchy of Savoy, afterwards called the kingdom of Sardinia, occupied with regard to the rest of the Peninsula. But in the colours of that map you will see the proportion in the north-west corner which that kingdom occupied. So situated and so circumscribed, it is a matter of marvel that it should become at last the governing and motive power of Italy. As I have said, a repose which is not peace, rested upon Italy, until at last the dry bones began to move, and a new spirit was breathed into them. The proclamation of the Spanish Constitution at Naples, in 1822, gave the first evidence of reviving power and sentiment in any Italian country, too soon, unfortunately, to be quenched in defeat, for the progress of the Neapolitan Government was checked by the disastrous affair at Benevento, and then, for long years, there was no more speech of war. But the spirit was alive, and as time rolled on the Piedmontese Government more and more developed constitutional action, and began to prepare for the contest which it was seen was inevitable. I remember, in 1836, as I have mentioned before from this place, Field Marshal Radetzky prepared two alternative lines of defence in the valley of the Po. The attack was expected by him from the west, and from the west it came, but not in the shape which he anticipated. He believed that the French would exercise their newly developed power in attack, probably with the alliance of the Sardinian kingdom, but he little expected that Sardinia would confront Austria single-handed. We know the result of that bold and resolute movement—armies broken, the Sovereign an exile, and dying of a broken heart in Lisbon. But not, therefore, did the kingdom of Savoy abandon its true and noble confidence in the regeneration of Italy. Years passed on, and again the arbitrament of battle was appealed to by the sub-Alpine kingdom, and with a result which, as we know, gradually brought country after country into that mass of power which is now reigned over by Victor Emanuel, the King of united Italy. In the circumstances of those wars there were some curious and remarkable results. From the beginning the Sardinian kingdom had to rest exclusively on its own strength; the fighting power was gradually developed into a greater efficiency, step by step, as each successive government declared its adhesion, because this must be borne in mind, that no portion of Italy was conquered, so to speak, but that, being set free from the rule of its native government, it voluntarily joined itself to the Sardinian State. There were, besides, some conflicts fought single-handed—some disastrous—none dishonourable. There were battles fought in concert with the French Army, and in result of these, though falling short at the time of what might have been anticipated, though Italy was not conquered, as the French Emperor had promised, "from the Alps to the sea," yet progress was attained; it was evident that some future day would give to Italy all that she could desire, just as previously the protracted resistance, made both at Rome and at

Venice, gave promise of what might be hereafter the lot of that country in a better day. And so at last Italy, with the exception of Rome, was won. "From the Alps to the sea," no foreign soldier rode or mounted guard on her soil, and the question then was, how, from the discordant materials of the Italian forces, a national Army could be constructed which should be sufficient to hold the country, first against invaders, and then against powers that might seek to enforce compromising alliances. Now, it will be observed that the different districts of Italy are separated from each other, not merely by natural bounds and limits, but also by the diverse genius and fashions of their people. The Northern Italy of Savoy has more of the feeling of the races beyond the Alps; the Lombard and the men of Venice are of one mode of thought, and those of the States of the Church and the Emilian Legations of another; and so of Tuscany, of Naples, and of Sicily, and the problem was, how to mould these into one homogeneous mass.

But, before I proceed further to show you how worthy the Sardinian Army was of the great task that lay before it, let me, from the simple records of its Army List, mention some facts which are well worthy of remembrance. Sardinia, or the new kingdom of the Savoy Duchy, has been known in the successful scientific wars of Europe since successful scientific wars began. We remember that the feuds and wars of the middle ages eminently brought to the surface the great Italian qualities of fiery courage, of resistance, of endurance, and of scientific application of mechanical means, so far as they were understood, in engineering and artillery, but it is not remembered, probably, that amongst the regimented forces of Europe few or none are older than the Italian. I find, in the Army List in which an account of the different regiments is given, that the third regiment, called that of Piedmont, dates from 1637. I believe that is older than any regimented corps in our country, and older, I think, than any borne on the rolls of France, or Austria, or Spain, or of any military power except that of Russia. These regiments distinguished themselves in many battles of the latter part of the 17th century and the whole of the 18th century. It is scarcely necessary for me to read to you the long roll of their distinctions, but those who remember the wars that have occurred in the last thirty years, and especially some to whom I now speak, who were companions of the small Sardinian Army by the waters of the Tchernaya, well know that they were soldiers, and have been soldiers at all times, with whom the English soldier might well be proud to bear privation and to mingle his blood. As of the infantry, so of the cavalry and so of the artillery and engineers. In this Army List you will find that gradually the Armies of the different countries that joined themselves to the sub-Alpine kingdom were absorbed and are borne on their rolls; but here was an enormous difficulty. Austria, with her repressive policy, had forbidden the youth of the Milanese, of Lombardy, and Venetia to cultivate their natural genius for arms and warlike science. The troops of Tuscany were trained on the Austrian system, but were comparatively small in number: the Neapolitan Army was trained and drilled

under the last King and his predecessors to an extent which gave them an admirable appearance under arms, and the thorough "*allure militaire*" which is so desirable; and yet, such was the fault of the Government, that this Army melted away before Garibaldi's red "camisade" as the snow before the sun, but has since re-entered in the persons of its Officers into the service of the King of Italy. I say in the persons of its Officers, because this is a point to which I shall direct attention. The men of the Italian Army undergo a more constant and searching change than those of any Army raised by conscription. How is this effected? In the administrative system of the Italian Government the principle is that a Minister of War shall lay what is called a "project of law," specifying whatever alterations he may desire to propose, first before the Chamber, and then before a Committee to be appointed by the Chamber. There is no examination of witnesses or appointing Committees in our sense, but the Committee, generally some sixteen or seventeen Deputies, examine the project themselves, and require such explanation from the Minister as may be necessary to satisfy themselves of the feasibility of his plans. These are very elaborate, and are carried out with a care and attention which is very remarkable. The volume before us comprehends the three projects of law on which the organization of the Army is now carried out, and it is exhaustive, as may be supposed, from the searching qualities of Italian genius. It goes into every question that can possibly concern the soldier, from the chief of the Army to the youngest recruit in the ranks; and some of the conclusions are exceedingly noteworthy, being drawn, not only from the personal experience of the Committee, but also from the incorporation of that which appears to be advantageous in the practice of foreign Armies. For instance, to commence with the main point of the recruiting, with regard to the exhaustive principle on which it should proceed, there was a very long series of discussions as to the nature of the service in the first instance, and that was decided to be personal conscription for every male subject in Italy, not disqualified by physical incapacities or exempted by certain family circumstances from service. Then came the question, what manner of Army there should be. And it was decided that there should be first an Army which could take the field, with a reserve, an Army answering to the Landwehr or the Militia of our country, and then a communal Militia, resembling the local corps which obtained in this country during the great French war; and, finally, Alpine corps, which are regarded as exclusively designed for the defence of the mountains. Then came the consideration as to whether there should be any exemption, or what provision should be made for those brought into the ranks. The principle is at present to raise the troops, 90,000 men, in what are called two categories. The first category consists of 65,000 men, who are raised according to proportions determined on a fixed system, throughout the military districts of the country; and this proportion joins the colours and remains with them, three years for the infantry and six for the cavalry; and the 25,000 remaining in the second category are taken to maintain the original strength of the Army in

line during the years of their service, that is to say, at the rate of about 10 per cent. And it is expressly laid down that those who happen to be placed in the second category, that is the category of temporary exemption, or deferred time of service, have no right, on that account, to be placed in the third category, that is to say, the Militia of the provinces or communal, but shall continue to form the second category. And I may mention this, in order to show how thoroughly a fair and true spirit pervades the whole of the Italian system. It was laid down expressly in the deliberations of this Committee, that there is only one hardship in forced service, and that is inequality.

Then with regard to the command of the Army. In the Italian service there is no permanent rank above that of Lieutenant-General. For the great commands, an officer styled "Army-General" is selected, equivalent to the temporary rank of General Commanding in Chief. And this question is also argued out with a greater closeness and at greater length than I care to detain you upon at present; but in this argument, and this shows you how thoroughly they have investigated every question, the Committee remark particularly upon the singular felicity with which H.R.H. the Field Marshal Commanding in Chief in this country has managed so to perform and carry forward our military institutions that he has made the armed soldier acceptable to his countrymen in a free state.

Then in this further analysis that I am speaking of, with the close prevision that is applied to all these subjects, I find in the distribution of an army of 100,000 men the proportion of infantry of the line to be 66,740, of bersaglieri 11,032, cavalry 4,849, field artillery 6,810, garrison artillery 4,086 pontoon train 572, engineers 2,179—a large proportion, —and transport 3,732. And the remark on the cavalry is this: that whereas cavalry is an arm difficult to maintain, and expensive also, and on these accounts to be adopted with much circumspection; that though certainly cavalry regiments may make a more brilliant campaign, yet for a country provided with sufficient fortifications, with an infantry it can trust, and with arms of defence, and with determination, as we say, to expend the last man and the last shilling, a brilliancy is not required which is in excess of what is necessary for the defence of the country.

The proportions of the conscription, of which I have spoken are somewhat remarkable. I have before me a table giving the estimated proportion of troops from 1872 to 1885. To avoid confusion, I have taken three periods—1872, 1878, and 1885. The annual contingent of 1872, permanent and in reserve, was 632,700 men; in 1878 it will be 736,700; and in 1885, 767,600. Under the first system, the troops were four years with the colours and twelve years liable to service; under the second system, which now prevails, they are three years with the colours and twelve years liable to service.

Having thus obtained their war numbers, the War Office proceeds to complete establishments with wonderful accuracy and minuteness. The artillery are to be provided with 1,000 field guns, of a description of which I shall have to speak, and with 800 steel B.L. field guns,

equivalent to our 16-pounders. The fortresses are adequately provided with artillery, and, as will appear further on, arrangements are made for the maintenance of the fortresses in an efficient state. I will now remark the care that has been taken with regard to the comfort of the soldier. The recruit is brought from hill or plain, as the case may be, but at all events, generally speaking in Italy, from secluded districts, at once into the Army, and is passed through the ranks. The system of military conscription is here carried out, I believe, to the most efficient and least hurtful extent in respect of the industry of the country. The principle is, that each Italian regiment shall have a certain proportion of recruits from different military districts, determined before-hand, that is, one-fifth from each of five different districts. Thus, though the soldier is not entirely separated from his friends and comrades of the district from which he was recruited, he is not only passed into a foreign garrison, so to speak, where he learns much of his countrymen that he has never known before, but he also learns it in the comradeship of those whom he thereby learns to respect and to appreciate. Thus, for instance, in recruiting for the infantry, I take the case of one particular corps; the first infantry regiment receives its recruits from five districts, from Alessandria, from Bergamo, from Sienna, from Naples, and from Palermo. I shall have, further on, to mention the circumstances under which these recruits are personally brought into the service.

I might detain you for some time on the general subject of establishments, but the work which has been published by our Topographical Department, "The Armed Strength of Italy," translated from the German by Lieutenant Hare, R.E., gives so clear an account, that I would refer you to its pages. There the general arrangements appeared to be very much as they are now carried out, though from time to time there must be, of course, considerable alterations. Permit me, then, for a moment, in the absence of detail, which time does not permit me to give, to ask credit for the military establishments being complete. I shall shortly proceed to give you some details as to some of the special establishments, but we are now arrived at the point that we have an army, we have the principle of appointing Officers, and the mode in which the soldier is brought into the ranks. When the soldier is in the ranks the question is, how he is dealt with. He is kept for three years nominally in the infantry, but for two years and eight months practically with the colours; he is then returned to his district, and is not allowed to remain, except under special circumstances and as a volunteer. It will be asked how are the non-commissioned officers to be obtained? Non-commissioned officers are obtained for the permanent service from battalions of instruction, which are organised very highly for their instruction on an uniform system; and amongst other points of interest to the Army, the question of how the non-commissioned officer is to be retained in the ranks is very minutely discussed. How to retain non-commissioned officers in the service is the question, and the answer is double, first in the negative and then in the positive direction. It appears that the hope or expectation of wearing the epaulette as commissioned Officers, will not retain the non-

commissioned officer in the service. For this reasons may be easily supposed. Then with regard to re-engagement, that does not appear to have been very successful, since if continued service does not decisively secure the future, no one will choose to expend in the service of the State the best years of his life, that is, those years which alone can create a sufficient provision for after-life.

But there are two special recommendations, one to recognise the right to employment, both staff and civil for long service; and the second is, and this a very remarkable one, and as far as I know novel, to create an intermediate grade between the Italian non-commissioned officer and the commissioned Officer. The Italians believe that these provisions will succeed very well, and this is one of the points on which we should have derived so much advantage from the opinion of the distinguished General, had he been present. I mention these things to show you the care and attention which are paid to regimental and other matters. Now I will take the case of the various duties and points of interest which come under the notice of the committees on military matters. Of the recruiting I have spoken. Then before these committees such matters are discussed as extraordinary expenses for the defence of the country, for the organization and *matériel* of artillery, for heavy field guns, for firelocks, for mobilisation of the Army, and for the defence of the sea-coasts. Another matter that has very much occupied the attention of the Italian Government in these references, has been the position of the Topographical Corps in the Italian Army. And this is remarkable; the Italian staff has been but twelve years in Sicily, and in that twelve years, with no very great amount of help, a map has been completed of contours, in beauty of execution in no way inferior to any that I have seen. In the report of this department a highly important scientific question is discussed, which I recommend to your notice, and which no doubt has attracted the attention of our Survey department. The question is not only the scale on which military plans should be drawn, but whether every section of a military map should be a precise portion of the great system comprehending the kingdom, or whatever other district may be selected, just as it is in actual fact on the ground. And here discussion arises as to the variable and comparative difficulty of forming such maps as shall be absolutely and positively true in reference to all points, if they be countries running north or south, or east or west. All scientific Officers present will at once see the difficulty arising from the different parallels, and this is what the Italian topographical staff have addressed themselves to obviate. The system adopted is called the polycentric system; that is to say, each separate sheet, instead of having an assumed uniform reference at all points to all other sheets, is taken in reference to the particular selected district, so that the whole of this district, though it does not absolutely and perfectly correspond with the entire surface of the larger and outer districts, is complete in itself, and one centre of proportional reference is taken in each sheet or district, and is therefore called the polycentric system, which now attains, I believe, most successful results in Italy.

Before I pass on, let me speak of the purpose for which alone this

Army is intended, and that is, of national defence. There is a proverb now, derived from one of these reports, which says "L'esercito che ha fatto l'Italia fara anche gli Italiani." The Army which has made Italy a State is making the Italians step by step, in bringing all classes of men of all her provinces together, to honour and respect each other, through mutual knowledge, and is prepared especially in the person of its officers for sacrifices of any extent, for the advancement and for the defence of their country, as appeared in these reports.

With regard to the purposes of defence, there may be said to be five classes of war in Italy—the war of the Alps, the war of the Apennines, the war of the river system, the war of the coasts, and the war of fortresses. For the war of the Alps, the passes are being strongly fortified with small forts and heavy guns, and garrisoned by the Alpine corps. For the war of the Apennines the light field guns are designed, because, as the Italian Minister of War said to me, "What could we do in our mountains with your great and heavy artillery?" For the war of the plains, there are troops fitted for close battles. For the war of the fortresses, there are the old works, relics of Austrian rule, which have been placed or retained in a condition of service, and there is no spot of possible offence to the country, I firmly believe,—from the returns I have now lying before me,—for which absolute provision for defence is not made or projected. And there is this remarkable in the calm courage and foresight of the Italian Government, that they never hesitate to declare what the objects of their defence are. In what we should call our estimates, they set forth that Rome is to be fortified by an entrenched camp, to secure the capital from sudden attack, and to guarantee it from the risk of bombardment with an ordinary siege-train. That Capua is to be fortified as a depôt for stores, and of "appui" for the defence of Naples, and would make her independent of the chances of Upper Italy, to protect the capital against attack from the south, and to cover the retreat on Naples of an Army which might be obliged to abandon Rome. And a nation who are so determined to sacrifice the brilliant in favour of the useful, who do not hesitate to declare, in the face of day, what their intentions are, must needs cause themselves to be respected, even in this first flush and youth of their union. Again must be noticed the war of the coast, and it is here that Italy has so great an advantage. Italy has the same advantage, from her long sea coast and her growing maritime power, that makes England, for imperial purposes, the strongest military power in the world, that is, in the possession of sea-bases from which expeditions can be launched against the most remote of her enemies.

Now, having given very briefly and very imperfectly a general outline of the Italian Army, let us see its application.

First, as to the recruits. The levies of the military district of Rome were, on the first of January in this year, taken for the first time. It was a matter of some little anxiety, for Rome had been accustomed to no soldiers but mercenaries, and I, with some curiosity, watched the recruits. Nearly 1,700 men walked into Rome, in the

early days of winter, from their mountain and village parishes. They came clad in goat-skins and shod with sandals, and such equipments as befit the mountaineer, but with small thought of wearing a shoe, or putting on a uniform or a shako. H.R.H. Prince Humbert did the British Officers the honour to request their attendance at the inspection of these levies. 1,672 were due upon the list, and 1,625 were in rank. Although only ten days together, the teachable and docile qualities of those young recruits, shown in steadiness and aptitude for service, reminded me of the race from which they sprang. It was a remarkable sight. Those of my hearers who have been at Rome will remember that the great parade-ground is formed of the camp of the Prætorian Guard, the famous, though turbulent soldiers of the Empire. The parade stretches below the city walls; beyond are the magnificent hills of the Sabines, the Samnites, and the Marsi, those men who kept republican Rome at bay for hundreds of years, and at last were only conquered into allies. These very men were the ancestors of the recruits who were now to form a portion of the Army of Italy. I may be permitted to refer to a quotation which then flashed across my mind. Horace, in speaking of the Rome in his time, and how the youth had degenerated from their fathers, says:—

"Non his juventus orta parentibus
Infecit aequor sanguine Punico,
Pyrrhumque et ingentem cecidit
Antiochum Hannibalemque dirum;
Sed rusticorum mascula militum
Proles, Sabellis docta ligonibus
Versare glebas et severæ
Matris ad arbitrium recisos
Portare fustes, sol ubi montium
Mutaret umbras et juga demeret
Bobus fatigatis amicum
Tempus agens abeunte curru."

My rough English for this seems to be thoroughly realised:—

"And yet in sooth 'twas no such youth from parents such as these
Who dyed in Carthaginian gore the level of the seas;
Smote Pyrrhus of the ruddy locks, and stout of lith and limb
The stalwart chief Antiochus, and Hannibal the grim;
But manly seed of rustic breed, themselves old soldiers made
In youth to turn the stubborn clod, with Sabine pick and spade;
And homeward bear the billets hewn as thrifty mother bade;
What time the sun o'er mountain ridge was flinging
Swift shifting shadows over fell and scaur;
Lifting the yoke from wearied oxen, bringing
A pleasant hour with his departing car."

The equipment of the infantry is useful and serviceable in a great degree; and they have a most ingenious manner of carrying their spare ammunition. The Italian soldier fights but with one pouch; and for a long time I was puzzled to know how the ammunition was to be carried unless with the trouble of drawing every spare cartridge from the pack. But I observed in the upper part of the pack a packet which I thought contained the spare shoes. I asked what it

was. "Oh! it is the spare ammunition." The spare ammunition is placed in a ticking cover in this packet, and if the soldier requires fresh ammunition, he undoes the button, raises the left shoulder, and out falls the cartridge whether he be fighting in line or skirmishing. Then with regard to the Bersaglieri, those wonderful troops. They are picked men, the minimum chest measure is 33 inches, and they answer in a general way in appearance to our stout drivers. Their pace, and that of the Italian infantry generally, is rapid and somewhat exhausting. The pace was originally 160, now increased to 170 gymnastic paces, which are 39 inches, the ordinary pace of 30 inches 116, and the double is 136, of 32 inches. I do not know how long they can keep up this pace, but still it is very formidable, and in the case of the Bersaglieri is shown to be very effective.

With regard to the cavalry, two innovations have been introduced, one, as it appears to me, of undoubted merit, and the other somewhat doubtful. The Italian cavalry, the light cavalry especially, skirmish extensively, but the skirmishers leave the sword on the saddle when they dismount for the purpose of fighting with a carbine armed with a bayonet. The valise is suppressed in the service, and its place is taken by two saddle bags of sheep-skin, which have a very soldierlike and neat effect. The saddle is so stuffed that there is always a current of air passing over the back bone of the horse, and yet apparently does not shift; the saddle itself rests on a blanket folded in four.

With regard to the artillery, there is a special gun which I shall now have the pleasure of mentioning. It is a gun of very light draught, and I will ask the meeting to understand that those sketches represent actually and accurately the field-day, to which the War Minister kindly invited British officers. The gun itself is 2·953 inches calibre. The velocity given the shell is 1,312 feet per second, and with 12° 6′ of elevation it ranges 3,828 yards. The elevation for shrapnel is one-fifth greater, and it is used up to 2,515 yards range.

The maximum elevation given the gun in the carriage is 22°.

The lightness of the gun-carriage and limber, the high initial velocity given to its projectile, and the consequent long range, place the Italian field artillery in the foremost rank as to efficiency.

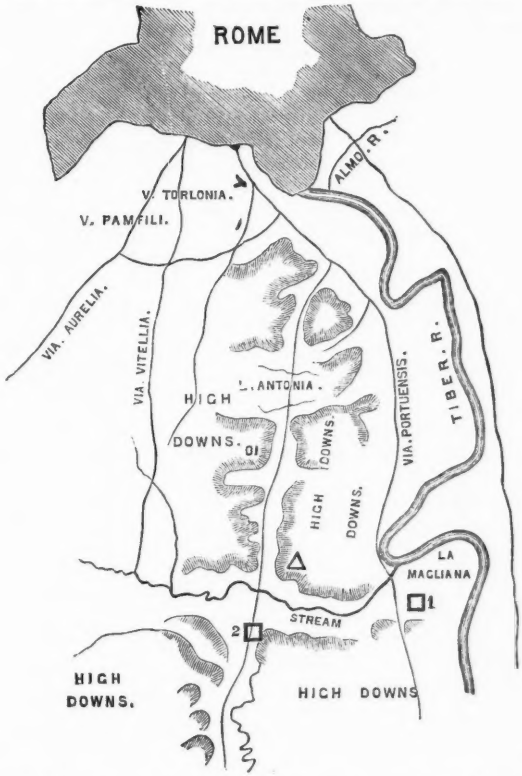
Sir WILLIAM CODRINGTON: Is it 22° ?

Lord WAVENEY: The common shell at 12° 6″ gives a range of 3,828. The other tables are not given. This gun is most effective with four horses and five men to a gun detachment. Two men sit with the gun, two on the limber, and one on the waggon. In case the waggons are not up, a non-commissioned officer is dismounted. This gun is the subject of a paper, well deserving reference, in the Transactions of the R.A. Institution, by Colonel Maxwell, R.A.

The diagram represents the country to the southward of Rome, and the Tiber below Rome. The idea of the manœuvre was that this body of troops was to hold their ground against a force advancing on Rome, for two hours, at the end of which time reinforcements would arrive. This stream, La Magliana, runs into the Tiber; and the lower part of this ground, with the exception of the road, was neutralized for the purpose of manœuvre. The troops left their barracks about 8.30 A.M.,

the nearest point of ground was about five miles: the furthest about six-and-a-half. They began manœuvring at twelve, manœuvred in earnest for two hours, marched back again, and there were only three men in the ambulance. The force was composed of five battalions, three of Bersaglieri and two of infantry of the line, with ten guns, six

THE MANŒUVRES OF THE MAGLIANA, JAN. 28, 1867.



△. Centre of defence. □1. Right flank of attack. □ 2. Left flank of attack.

for the attack and four for the defence, and a squadron and a half of cavalry, equally distributed. The cavalry came very little into action, as you will suppose, through not seeing them included in the sketches which represent three separate periods of the manœuvre. The custom of the judges is to take two halts during the manœuvre for the purpose of, as it were, taking count, and thus according the value of the

points verified at these periods of halt, the decision is regulated. My impression is, the condition on which the manœuvre was undertaken was thoroughly carried out, and that the ground was held for two hours.

The first movement was by massing the attacking force on that point, □ 1 (*Diagram*). The troops then moved athwart the crest of these hills till they reached the furthest point of formation, □ 2. The proper right of attack of the assaulting force was from the buildings, near the confluence of the Magliana and Tiber; the proper left of the attack from these buildings, a mile and a half to the westward. This central point was the point of defence, at which the head-quarter staff was posted. On the development of the Bersaglieri attack from the right, a portion of the troops were thrown into an oak wood in column of companies, and a portion were retained in hand. Four guns were brought up to the salient of the point △ to bear on the Bersaglieri if they should make a flank-attack from their left or westward. This ground is exceedingly steep, and was therefore considered to be very favourable for defence. The action was commenced by heavy firing from the central point of the enemy's alignments upon our position, which was very much exposed. I have mentioned that the ground below was neutralised for the purposes of the manœuvres, and indeed it would have been very difficult to have carried troops or guns across. There is a road leading to Rome through the flat with a bridge, of which the Bersaglieri availed themselves to make a false attack in the first instance over the ground; and immediately below the central position of defence in the centre is a nullah, about wide enough to jump a gun across; but the Bersaglieri hid themselves so completely in it as in a shelter trench that from this high ground but little or nothing of the troops below could be seen.

Having made this false attack from their left, another attack was precipitated from the right which brought the defence out of the wood and left them prepared to deploy as soon as the attack from the right should attain sufficient importance. This was the closing scene of the manœuvre. The guns were withdrawn from the centre of defence towards the left flank, and then opened on the advancing troops. The skirmishing which was to protect our right was carried on to the rear, and the men were formed facing the left or false attack.

The light guns were most effectively and efficiently worked with their four men per gun detachment, and non-commissioned officers; and I saw the guns of the attacking force brought up a very steep incline in perfect order, and simply by four horses. It gave us all an impression of the hardihood of the Italian soldier, and there were officers present well acquainted with the power of infantry movement who were struck with what they call the "gliding" pace of the Bersaglieri.

My time has now come to an end. I am exceedingly sorry I have not the opportunity of impressing more strongly what I have to say; but if I could only show you the accumulation of papers and memoirs which I have had to consult, and to consult always with advantage, you would say that the difficulty of choice was very great indeed.

The chief consideration is this: The strength of armed Italy is in the system which has formed the veterans of her Army. They have done work which few other soldiers could have done under the circumstances. They have set themselves thoroughly to do their duty to their country. They are by degrees indoctrinating the whole of the Service with the stern, fixed principle of the northern military spirit. Those who have been their companions in camp and garrison will know how to value these gallant men. For readiness, for steadiness, for good conduct, the troops are to be most highly commended, even in such a difficult capital as Rome. Orderly and quiet, with the best qualities of the unspoiled soldier, they have learned that the profession of arms is an honourable one; and that though it may be difficult to maintain it in its integrity, and though the pains and troubles that wait upon it sometimes appear excessive, yet the Italians, who had little thought twenty years ago of what the merit and honour of the military service was, have now been converted into an army and a country of constitutional soldiers.

Let me now show to the ladies present how noble a share their sisters of Italy took in the war of liberation.

I read a poem of Mrs. Browning's entitled:—

"A Court Lady."

"Her hair was tawny with gold, her eyes with purple were dark,
Her cheeks pale opal burned with a red and restless spark.
Never was lady of Milan nobler in name, and in race;
Never was lady of Italy fairer to see in the face.
Never was lady on earth more true as woman and wife;
Larger in judgment and instinct, prouder in manners and life.
She stood in the early morning, and said to her maidens, 'Bring
'That silken robe made ready to wear at the Court of the King.
'Bring me the clasps of diamond, lucid, clear of the mote,
'Clasp me the large at the waist, and clasp me the small at the throat.
'Diamonds to fasten the hair, and diamonds to fasten the sleeves,
'Laces to drop from their rays like a powder of snow from the eaves.'
Gorgeous she entered, the sunlight which gather'd her up in a flame,
While straight in her open carriage, she to the Hospital came.
In she went at the door, and gazing from end to end;
'Many and low are the pallets, but each is the place of a friend.'
Up she pass'd through the wards, and stood at a young man's bed,
Bloody the band on his brow, and livid the droop of his head.
'Art thou a Lombard, my brother? Happy art thou,' she cried,
And smil'd like Italy on him; he dreamed in her face and died.
Pale with his passing soul, she went on still to a second;
He was a grave hard man, whose years by dungeons were reckoned.
Wounds in his body were sore, wounds in his life were sorer;
'Art thou a Romagnole?' Her eyes drove lightnings before her.
'Austrian and Priest had joined to double and tighten the cord,
'Able to bind thee, O strong one—free by the stroke of a sword.'

* * * * * *

Down she stooped to a pallet where lay a face like a girl's,
Young and pathetic with dying—a deep black hole in the curls.
'Art thou from Tuscany, brother? and scest thou dreaming in pain;
'Thy mother stand in the piazza, searching the list of the slain.'
Kind as a mother herself, she touched his cheek with her hands,
'Blessed is she who has borne thee, although she should weep as she stands.'

On she passed to a Frenchman, his arm carried off by a ball;
Kneeling 'O more than my brother! how shall I thank thee for all?
'Each of the heroes around us has fought for his land and line,
'But thou hast fought for a stranger, in hate of a wrong not thine.
'Happy are all free peoples too strong to be dispossessed,
'But blessed are those among nations who dare to be strong for the rest.'
Ever she passed on her way, and came to a couch where pined
One with a face from Venetia, white with a hope out of mind;
Long she stood and gazed, and twice she tried at the name,
But two great crystal tears were all that faltered and came.
Only a tear for Venice? she turned as in passion and loss,
And stooped to his forehead, and kissed it, as if she were kissing the cross.
Faint with that strain of heart, she moved on then to another,
Stern and strong in his death—'And dost thou suffer, my brother?'
Holding his hands in hers—'Out of the Piedmont lion,
'Cometh the sweetness of freedom! sweetest to live, or to die on.'
Holding his cold rough hands, 'Well, oh well, have ye done
'In noble, noble Piedmont, who would not be noble alone.'
Back he fell while she spoke, she rose to her feet with a spring,
'That was a Piedmontese! and this is the Court of the King.'"

To H.R.H. Prince Humbert the respectful thanks of the British Officers present at Rome are eminently and in the first place due.

And I avail myself of this opportunity to express our sense of the constant courtesy shown to us by Lieut.-General Ricotti, then Minister of War; by Lieut.-General Cosenz, Commanding Military Division; and by the Staff and Officers in garrison at Rome.

OCCASIONAL PAPERS, NOTES, AND NOTICES OF BOOKS.

RECENT REFORMS IN THE RUSSIAN ARMY.

By Captain F. C. H. Clarke, R.A., D.A.Q.M.G.

In the following pages it is proposed to present to the reader a short outline of the chief reforms which have been introduced of late years into the Russian Army, more especially during the last two years, 1874–1875: an epoch which cannot fail to be characterised in the future as one of great military activity, not only for Russia, but generally for the whole continent of Europe.

The reform which first attracts our attention is, naturally, that fundamental one which affects the whole fabric of the commonwealth: the introduction of general obligatory service for all classes of the community. Its main object, as is also the case with the other reforms, is to increase the numerical strength of the army.

The great development of the armed forces of the European Powers during and after the war of 1870, had caused Russia to recede into the background when estimated from a numerical point of view, whereas eight years previously she had held the foremost place in this respect among her immediate neighbours. Thus, in 1862, Prussia had an army of 775,000 men, Austria of 700,000, and Russia of 1,300,000 men. In 1870, Germany had increased her effective to 1,310,000 men, Austria to 1,000,000, while the forces of Russia had undergone no augmentation. This was considered an unsatisfactory position for the nation, and a commission was appointed to consider the whole question of recruitment and reserves. After mature deliberation, extending over a period of two years, during which the subject was ventilated from every point of view, and the opinions and interests of all classes were consulted and weighed, the commission ultimately submitted, for the approval of the Emperor, the project of a new law for regulating military service. This project, after being altered somewhat in its details, but not in its general principles, by the Emperor's immediate advisers, became law on the 1st January, 1874.

Although the introduction of general obligatory service must be regarded as the first radical reform to which the army has been subjected of late years, it would be incorrect to suppose that it broke suddenly upon a *régime* existing from the time of the Crimean war, and that the experience of that campaign had been lost upon the nation. On the contrary, immediately after the peace of Paris, we

find the Russians examining their military system and remedying the more prominent shortcomings and defects under which it was labouring. But the hand using the pruning-knife, instead of proceeding to the root, touched only the more prominent excrescences on the branches. The ground for any fundamental change was not yet ready.

The path of progress in army-reform was so hampered by conflicting interests that no changes of a radical character were possible, until the impediments which beset it could be removed. At length the day dawned when the onward progress was to be freed from the trammels restraining it. The emancipation of the serfs by the present Emperor in 1861, cleared the way for reform in the military system, as it did for those numerous other amendments in the constitution, which, in process of time, if as steadily followed as commenced, will serve to raise Russia to the level of other European nations.

So long as the serfs constituted the great source from which recruits for the army were derived, any augmentation of the yearly contingent, with a view to passing a greater number of men through the ranks into the reserve, was so very unwelcome a measure to the proprietors as to be well nigh impossible. In order to avoid interfering with the rights of the latter, so time-honoured as almost to be sacred, the Government was obliged to forego any increase to the reserve, and as compensation, to retain the men present with the colours as long as possible. Another evil was that the ranks became the receptacle of all the dross of the community, the proprietors and communes being openly invited to make use of this means for relieving themselves of their bad characters. Service in the army, instead of being regarded in the light of an honourable duty, became a reproach and was looked upon as a stroke of misfortune not less intolerable than deportation to Siberia. So repugnant to men of self-respect was the profession of arms, that the Government was forced to allow every possible outlet for escaping service. Not only were exemptions accorded to those with rights appertaining to birth, to those exercising useful professions, and to those possessing certain educational qualifications, but also to those who had sufficient means to purchase membership of a guild. Failing the foregoing qualifications, any person drawn for the army could purchase exemption, or provide a substitute to take his place in the ranks.

Exemptions in the regular army had increased to such an extent by the year 1873, that of a male population of thirty millions in European Russia, exclusive of Poland and Finland, only about twenty-four millions were liable to military service. And if we further deduct from that number those who purchased exemption, it will be found that about one-fourth of the population was free from service in the army.

Again the system adopted in levying the contingent of recruits opened the door to many abuses. It was entirely in the hands of the communal authorities, and, as might be expected in a comparatively rude state of society, the latter were not inaccessible to influence in making up the

contingent of recruits. The communes had also to provide certain articles of clothing, food for three months, and pay for the recruits.

Consequently, the burthen of military service fell with its entire weight upon the citizen who was too poor to purchase exemption, and upon the serf class, while the expenses of furnishing and equipping the contingent formed a heavy charge on the commune funds.

The year succeeding the emancipation of the serfs was marked by the commencement of some important army reforms, which, however inceptive and incomplete in their character, must be looked upon as strides in the right direction. These reforms were the following; the various units of troops were to be increased to such an extent, that, with a small establishment in time of peace, they would provide sufficient cadres for the army whenever the time should come to raise it to the war footing; the men requisite for augmenting the army to the war establishment were to be sent on furlough, ready to be called up if required. Certain changes were introduced with a view to the more efficient training of recruits, the local troops were reorganised and the number of non-combatants was considerably reduced.

But scarcely had these changes time to bear fruit when the two great wars of 1866 and 1870, sudden in their outbreak, and rapid in their course and result, shewed that victory attaches itself to that army, which, in time of peace, has the different parts of its complex machinery so perfect and arranged, that it can be set in motion in any direction without friction or delay; and, when set in motion, is able to strike a blow of superior weight, and has the means for sustaining its continuous action.

In order to understand how far from satisfying these requirements was the Russian Army of the time of the Franco-German War, and to appreciate the reforms since introduced for its amelioration, we must further glance at the general principles of the organization which obtained previously to the recent changes.

The Russian Army consisted then, as now, of the regular army, the irregular troops, and the militia.

The yearly contingent of recruits for the regular army was divided into field and local troops; the former were intended for operations in the field, the latter for home defence, training recruits, defence of fortresses, and the performance of local duties in general.

The irregular troops consisted of the Cossack contingents, and the militia of the Caucasus and Trans-Caucasus. The service of these troops was subject to special provisions.

The militia, analogous to the German landsturm, could only be called out under special circumstances of danger threatening the mother country.

Up to the spring of 1874 the regular army was recruited from those liable to service and by volunteers. Those coming under the first classification were such as paid a capitation or equivalent tax, former crown, or appanage peasants and original serfs. The nobility, merchants, parish authorities, colonists with certain privileges, inhabitants of certain districts, and many others were exempt. The intellectual class of the community, therefore, was not represented in the army.

Recruits were not to be less than twenty-one nor more than thirty years of age. It by no means followed that a man passed over at one of the levies would not be drawn in some subsequent year. He could not, therefore, feel himself free to enter upon other pursuits until he had passed the limit of age. The duration of service was twenty years for those enlisted prior to September, 1859, and fifteen years for those entering the Army subsequent to that date. After thirteen years, those under the former rule could be granted indefinite furlough, and those under the latter, after ten years. Lastly, the authorities had the power to send men of good character on furlough after eight years' service, provided the effective was above its normal strength. Men on furlough, whether for an indefinite or for a fixed period, were included in the reserve, and could be called up to serve if required.

Volunteering for the army, for periods of fifteen, ten, or even five years, was open to every Russian subject.

From the foregoing brief sketch it will have been seen of what faulty elements the Russian Army had been composed previous to the introduction of the new law, and how unequally the burthen of military service weighed upon the population. Let us now see what important changes the new law has inaugurated.

New Law regulating obligatory Military Service (*January*, 1874).

The main features are, that the enrolment of criminals and of persons of ill-repute has been abolished; the term of service has been reduced to fifteen years, of which six years are passed in the active army, and nine years in the reserve; the number of exemptions has been curtailed as much as possible; many impediments and conditions have been set aside in the admission of recruits; the system of paying money to provide a substitute is no longer permitted.

These reforms, trenchant as they were in curtailing the freedom of a section of society, which up to that time had looked upon immunity from military service as its prerogative, were accepted generally in a cheerful spirit throughout the empire. This circumstance must be the more satisfactory to the Emperor and his advisers, as the feeling of the people in favour of the change was not born of disaster as are so many radical reforms, but was the offspring of serious meditation in time of peace.

The new law divides the armed forces into *active army*, in which the period of service in European Russia is six years,[1] the *reserve*, to which men who have passed through the army, belong for the next nine years,[2] and the *militia* or general levy, in which all are included

[1] Although the term of service in the active army in European Russia is six years, the War Minister has the power to grant furloughs to men before the expiration of that period. Furloughs, not exceeding a year, may also be allowed at any time during the term of service.

In Turkestan and Asia the term of service is seven years in the active army, and three years in the reserve.

[2] During his nine years' service in the reserve a man is on permanent furlough, is placed under the civil law, and may pursue any calling or occupation. He is liable, however, to be called out twice for drill during these nine years, each time for six weeks.

who are capable of bearing arms, from the age at which they are liable to service to the completion of their fortieth year. This law is applicable to the whole empire and to Poland, but not to Finland.

The number of men necessary to complete the army is decided each year by law. The distribution of the yearly contingent among the Governments and districts is made by the War Ministry proportionately to the number of persons in each who are liable to service. A more detailed distribution is afterwards drawn up by the Government and district commanders. The actual levy, the lot-drawing and examination of the conscripts devolves upon the Circle Commissions. Those persons liable to be drawn are such as have completed their twentieth year in that year in which the levy takes place.

Besides, the men entering the army by lot-drawing, every Russian has the right to enlist as a volunteer, under certain conditions as to age, state of health, and educational qualifications. The degree of the latter determines his period of service, whether for three, six, or twenty-four months, at the expiration of which the enlisted volunteer passes to the reserve for nine years. Volunteers are allowed, as a rule, to select the regiment in which they are desirous of serving. Those entering the Guard must maintain themselves at their own cost, others may be allowed to do the same and to live in private quarters. All enter as privates, and, according to their educational qualifications, may be promoted to the grade of non-commissioned Officer after two, four, or twelve months' service, and to that of Officer after three, six, and thirty-six months' service in the non-commissioned ranks. No commission can, however, be conferred unless the applicant has served in camp during one period of exercise.

There is also another class of volunteer soldier called "amateur," who serves under analogous conditions to the three-years' volunteer of the German Army. This class is composed exclusively of men not liable to military service, and those belonging to the militia, provided they do not exceed thirty years of age. Their period of active and reserve service in peace is precisely similar to that for ordinary recruits. In time of war they are obliged to serve so long as it lasts, but are not afterwards included in the reserve except of their own choice.

The militia consists of all men not forming part of the standing army who are capable of bearing arms, and whose ages are between twenty and forty years inclusive. It also comprises all men released from the reserve. The men belonging to the militia are divided into two categories; the first consists of the four youngest classes, and is intended to form either distinct regiments of militia or to augment the ranks of the standing army in the event of the reserve being insufficient; the second category includes all the remaining classes, and is solely used for forming a distinct militia force.

The shortening of the term of service introduced by the new law, and the obligation for all classes to serve, will place in the course of a few years a very large force of trained reserves at the disposal of the Government. In fact, so vast are the resources of the empire, some 700,000 men annually attaining the age of liability, that it would be possible and may appear advisable to shorten the period of service, by

which a still larger number of men will be passed through the ranks into the reserve. Let us explain by figures. The present peace establishment of the regular troops in European Russia is 760,000 men, to maintain which an annual contingent of 140,000 recruits would approximately be necessary. The actual number to be levied has been raised this year to 180,000, and even with this large contingent about three-fouths of those liable escape military service.

A comparison of the relative proportion of those levied to those liable in other countries, where conscription is in force, will show that the burdens of military service press least heavily in Russia. In fact, advantage is taken of the circumstance that there is so large an excess of available *personnel* to soften the measure of universal liability by granting postponements of entry, and numerous exemptions altogether from service when the grounds are good and sufficient. No other State accords such privileges to education. Not only is the term of service abridged for young men of culture who enter as volunteers, but for those also who take part in the lot-drawing. Even the most elementary instruction, that of the primary schools, confers the right of a reduction of two years (four instead of six) in the active service.

Again the exemptions on family grounds are most numerous. In other countries, these privileges are only granted, as a rule, to those who are the means of support of necessitous families; for an only son to obtain exemption, his parents must not only be sixty years of age, but must also have no means of existence. In Russia, the age of the parents is fixed at fifty-five; and not merely is the only son of aged parents exempt from service, but also the son of parents capable of looking after themselves.

Lastly, with respect to property, the law allows of postponement in the case of those persons whose presence at home is urgently demanded by their private affairs, whether such business be connected with landed property, commerce, or trade. In order not to throw any impediment in the way of exercising such professions as are necessary and useful to the State, exemptions and postponements are allowed in favour of the clergy of all Christian denominations, doctors, pharmaceutists, veterinary surgeons, artists, professors, tutors, captains of the mercantile marine, pilots, their apprentices, and others.

With regard to the rights accorded to soldiers, those in active service retain all their rights, personal or other, are exempt from all personal tax, and after discharge to the reserve, may proceed where they will. During their first year of reserve service, they are also free from taxes.

The military law of 1st January, 1874, affects only the standing army, the reserve, and the militia. In addition to these there exist the different Cossack contingents and some native irregulars, which are provided for by regulations of later date. The Cossacks retain their former institutions, which make every man a soldier and a colonist at the same time; the native population of the Caucasus and Siberia is expressly exempt from the new law, special regulations having been issued for these various tribes.

We will now proceed to mention the changes which have taken place in the organisation of the regular troops.

Army of the Caucasus.

The regiments of all the Infantry Divisions in the Caucasus military district have been increased by an additional battalion. Each regiment now consists of four battalions, of which three are line and the fourth a rifle battalion; each battalion consists of four companies. At the same time, in lieu of the four establishments[1] previously existing, only two are maintained: the *peace establishment*, of 24 files per division (half company), and the *war* establishment, of 54 files. In consequence of this arrangement, a battalion of a regiment on the war-establishment has very nearly the same strength as heretofore, because although the number of companies is diminished by one, the number of men in the company is increased by some fifty (54, instead of 42 files per division). In the general result, therefore, a Division on the new establishment has sixteen battalions instead of twelve.

The number of Infantry Divisions has been increased from six to seven by the addition of the 41st Infantry Division.[2] The 41st field artillery brigade, of six batteries, has also been newly created.

The nucleus for the formation of the 41st Division was given by the already existing fourth battalions of the Grenadier, 19th, 20th, and 21st Divisions; the remainder of the men were newly raised. The fourth battalions, given up by the Grenadier, 19th, 20th, and 21st Infantry Divisions, for the aforesaid purpose, were replaced by the men from the supernumerary fifth companies. To form the fourth battalions of the regiments of the 38th and 39th Infantry Divisions, were employed 6 line, 1 local, and 1 fortress battalion.

The general scope of the re-organization of the army of the Caucasus has been to augment the infantry of the field-army by 28 battalions, or in round numbers, by 280,000 men.

Abolition of the Cadre Establishment of Infantry throughout Empire.

All the regiments of those Infantry Divisions which were on the cadre establishment have had their effective raised from 16 files per division (half company) to 24 files, *i.e.*, to the ordinary peace establishment. This measure, while augmenting in a large degree the effective, and, in consequence, enhancing the state of preparedness for war, removed many disadvantages arising from the small numerical effective of troops on the cadre establishment.

There were 22 Infantry Divisions on the cadre establishment. By giving these Divisions an increase of 8 files per division (half company), the result has been to augment the army by about 43,000 men in time of peace.

[1] War, increased peace, peace and cadre establishments.

[2] The infantry of the Caucasus now consists of the Grenadier, the 19th, 20th, 21st, 38th, 39th, and 41st Infantry Divisions.

Re-organization of the Cavalry.

The seven Cavalry Divisions of the line[1] previously existing have been split into halves, and formed into fourteen Divisions, to each of which has been added a regiment of Cossacks of the Don. Thus, each Cavalry Division of the line, formed in two brigades, now consists of four regiments; one of dragoons, one of lancers, another of hussars, and the fourth of Cossacks, all bearing the same number as the Division to which they belong.

All regiments of cavalry are to have the full war establishment in time of peace, that is to say, 16 files per division (quarter-squadron).

In addition to the above, a separate Cossack Division has been formed of four regiments of Cossacks of the Don, also divided into two brigades.

Thus after the transformation, instead of ten Divisions of cavalry (including the Guard), as heretofore, there are eighteen, of which two belong to the Guard, one Caucasian Division of dragoons, fourteen Divisions of the line, and one Divison of Don Cossacks.

In time of war, it is further proposed to form three Divisions of cavalry of the Guard, and to split up the Caucasian Division into two, adding to both regiments of Cossacks. In this way the total number of Cavalry Divisions will be twenty.

Re-organization of the Horse Artillery.

This measure, rendered necessary by the new organization of the cavalry, consisted in augmenting the number of regular batteries of horse artillery from 18 to 26, but at the same time reducing the number of guns in a battery from 8 to 6. The number of Don Cossack batteries was also increased from 16 to 22, of which number 8 are permanently maintained in time of peace. This arrangement allows of each Cavalry Division being assigned two batteries of horse artillery.

Five regular batteries and one irregular (Don Cossack) battery of the Guard form the horse artillery brigade of the Guard, which is attached to the 1st and 2nd Guard Cavalry Divisions. The other batteries of horse artillery, not formed into brigades, are attached to the fourteen Cavalry Divisions of the line as follows: 2 regular batteries to the first 7 Divisions, and 1 regular and 1 irregular battery to the remaining 7 Divisions.

Changes in the Field Artillery.

The 41st Brigade has been newly created.

The greater proportion (44) of the brigades of field artillery stationed in European Russia now consist of three 9-pounder, two 4-pounder, and one mitrailleuse battery. The remaining four brigades have a mountain battery in lieu of the battery of mitrailleuses.

[1] Each Division consisted of six regiments of cavalry, viz., two dragoon, two lancer, and two hussar regiments.

Seven of the brigades are on the increased peace establishment, the remaining forty-one on the ordinary peace establishment.[1]

The war establishment of the artillery in European Russia, will, therefore, consist of 48 brigades of field artillery, with 288 batteries, or 2,304 guns, 26 batteries of regular and 22 batteries of irregular horse artillery, with 288 guns. Total 2,592 guns.

Reorganization of the Local and Fortress Troops.

The organization of the local troops has been completely modified, the first step to this being the final abolition (commenced in 1870) of the so-called reserve troops, upon which devolved formerly the training of the recruits. The recruits are now trained with the field troops.

The reorganization of the local and fortress troops, in conjunction with the issue of regulations for the formation in time of war of *reserve* and *depôt* troops, forms part of the great scheme of army reform, and is intended to relieve the field or active army from all secondary operations in time of war. The *reserve* troops, now so-called, furnish the men necessary to complete the army to the war establishment on mobilization. The local troops in time of war will perform all the home duties, and if necessary, supply men to form depôt and reserve battalions.

This reorganization has now been carried into effect. The local troops are now divided into two categories:—(1) local battalions and local detachments, of the same establishment in peace as in war, and (2) local battalions and local detachments, with a cadre establishment. The distinction is merely a matter of convenience. When there are regular troops stationed in the same garrison with local troops, the latter do not require so large an effective as in garrisons where they have to perform all the local duties.

Local battalions on the full effective vary in strength from 600 to 1,000 men, according to the extent of the duties in the garrison where they are quartered. Local battalions on the cadre establishment (400 men) are transformed in time of war into regiments of four battalions.

Local detachments on the full effective consist of 250 men. Those on the cadre establishment, varying in strength from 64 to 250 men, are transformed in time of war into battalions of 400 to 800 men.

The organization of the fortress infantry is also *en train*. In time of peace the fortress infantry consists of separate battalions, each of 4 companies, and each division (half-company) of 24 files. But in time of war the battalions are broken up, each company being then converted into a battalion of 4 companies, of 54 files per division. Thus each battalion will be transformed into a regiment of 4 battalions, each of 900 men.

The number of fortress battalions is given as 29 in time of peace. In time of war this number would give 116 battalions, or about

[1] On the increased peace establishment all eight guns are horsed, on the ordinary peace establishment only four.

120,000 men. These may be combined into Brigades and Divisions if necessary.

Such a large augmentation in the numbers of the fortress infantry on mobilization—more than eight times the peace effective—demands very large reserves both of men and material, and can only be carried into effect gradually. According to a recent order, measures have been adopted for getting the material in readiness for forming at first, in the event of mobilization, each fortress battalion into a fortress regiment of two battalions.

Organization of the Reserve and Depôt Troops.

By the issue of the regulations for the *reserve* and *depôt* troops, entirely new classes of troops have come into existence in the Russian Army. The former are intended for secondary military operations and for duties on the communications of an army, while the latter are charged with the timely preparation, training, and despatch to the theatre of war of the reinforcements necessary to replace casualties among the field and reserve troops of all arms. As their designation indicates, these two categories of troops are only formed in time of war.[1]

Each regiment of infantry and each rifle brigade (except those in Turkestan) is to have a depôt battalion; consequently, in all, there will be 12 guard, 16 grenadier, and 164 infantry depôt battalions, besides 1 guard and 6 rifle depôt battalions. These depôt battalions, however, do not appear to be in close connection with the field troops as is the case in Prussia, where each corps gives up on mobilization a portion of its effective to form the depôt (*Ersatz*) troops.

The organization of the depôt battalions of the guard, grenadiers, rifles and infantry of the line is identical. Each depôt battalion has four companies, and consists of a *cadre* and a *variable establishment;* the former includes the training staff, the latter furnishes the escorts for the convoys of reinforcements for the field troops, as well as the reinforcements themselves. There are no cadres in time of peace, but, on the outbreak of hostilities, the battalion is formed partly of officers, non-commissioned officers, and men from the nearest field and local troops and partly of reservists and militia of the 1st class. In order to accelerate mobilization the battalions are formed by companies, as far as possible at points selected for their central position with regard to the rayon of recruitment, and also with reference to convenience of communication. The clothing, arms, and equipments are stored in time of peace at these company centres, from whence, fully equipped, the companies proceed to the head-quarters of the depôt battalion.

The total number of depôt battalions—199—will give a force of about 260,000 officers and men, of whom 220,000 will be immediately available to replace casualties.

With regard to the *reserve troops*, this new creation is analogous to the Landwehr troops of Prussia; they are intended to reinforce or

[1] Except the cadres of the depôt troops for the special arms, which are also maintained in time of peace.

replace the active troops on the theatre of war. There are no permanent cadres in time of peace, but, on the declaration of war, the reserve battalions are formed, partly of officers and men from the field or local troops and partly of reservists. Their organisation is precisely similar to that of the active troops; complete stores of clothing, equipment, &c., are maintained in time of peace. For the present, until there are sufficient reserves at disposal for forming the 164 battalions contemplated, the number of reserve battalions will depend upon the reservists available after the active and depôt battalions have been completed to their war establishment. The reserve battalions will be combined, if necessary, into Brigades and Divisions.

When the whole number of reserve battalions is formed, the number of troops in this category would be upwards of 180,000 men.

Changes in the Conditions of Service of the Don Cossacks.

We now come to the changes in the organization of the irregular troops. The new regulations differ for the separate Cossack contingents. As a type we will take the Cossacks of the Don as being the most numerous and as being the force which it has been decided to employ in European fields of warfare.

According to the regulations previously in force, the regiments of Cossacks of the Don had no permanent organization. On the outbreak of hostilities, regiments were formed of the men in the military district, while the officers and non-commissioned officers were appointed from the whole contingent. Thus the regiments were a mass of men without any intimate cohesion. On the termination of the campaign, the men were dismissed to their homes, and every trace of the regiment disappeared. This system prevented the formation of the administrative and other services, and at the same time militated against all *esprit de corps*. The greatest defects would appear at mobilisation, which would be exceedingly slow, and would not correspond to the requirements of the time, when it is proposed to make use of these troops at the outset of the campaign.

The new regulations for the service of the Don Cossacks, which came into force on the 1st of January, 1875, took into account, on the one hand the new organization of the armed forces of the empire, and, on the other, the defects which experience had shown to exist in the previous constitution of the Cossack contingents. The Cossack force thenceforward received a permanent organization, which guaranteed a rapid mobilization in time of war, and permitted of the Don Cossack regiments being embodied in the Cavalry Divisions.

By the terms of the new regulations, the Don Contingent consists of the active troops and the militia. The latter is only called to arms under exceptional circumstances. The active class is divided into three categories: (1) The *preparatory*, (2) the *field*, and (3) the *reserve*. The *preparatory class* includes all young Cossacks between the ages of 18 and 21. During their first year in this class they perform no military duty, but are merely required to provide them-

selves with the necessary equipment. Their training does not begin until the autumn of the second year at their respective *stanitsas*,[1] and is continued through the third year. After three years passed in this category, the Cossacks pass to the *field class* for twelve years. From this class are drawn the men required for completing the detachments maintained in time of peace, and for filling up the entire contingent placed in the field in time of war. In time of peace, the actual period of service is never more than four years, and, as a general rule, will not exceed three, after which the Cossack will not be liable to be called up except for manœuvres or for war. For the remaining eight years of the service in the field class, the Cossack is granted furlough. After completing his full period in the field class, he passes into the *reserve class* for five years, during which time he is entirely free from service in time of peace, but in time of war would be liable to be called up to replace casualties.

From the year 1868 until the issue of the present regulations the term of service of Cossacks in the field category, that is to say, the time during which they were liable to be called up for service was 15 years, commencing with their 20th year. In addition to this, they were liable to *interior* service for 7 years. By the new law, the Cossack in time of peace would be free from military service after completing his 24th year at the latest.

According to the new regulations, the Don Cossack Contingent is bound to furnish, in time of war, 62 regiments of cavalry (including 2 Guard) and 22 batteries of horse artillery. Of this force, the following are to be maintained in time of peace:—The Body Guard Cossack regiment, 20 regiments of the line, 1 guard battery, and 7 line batteries of horse artillery. The line Cossack regiments consist of 6 sotnias, of 14 files per division (quarter squadron).

The Don Cossack territory is divided into five districts, and, as far as possible, each district furnishes the recruits for its respective regiments. For the artillery, the territory is divided into two sections. The distribution of the quotum of recruits among the districts is in the hands of the Ataman.

The 60 regiments are divided into 3 divisions of 20 regiments each; the first division is on duty in time of peace, the other two are on furlough. The men in the first division, after serving their time, are replaced by young Cossacks; those belonging to the second division have to keep their horses and equipment always available for instant service, those of the third division only their equipment.

As regards the horse artillery, the men belonging to those batteries which are to be mobilized in time of war are bound to have their equipment, clothing, arms, and riding horses in constant readiness. The guns, carriages, waggons, &c., are all kept in store ready for issue when required.

A proportion of Cossack troops are trained in railway duties by being attached for 2 years to certain lines of rail.

When the new regulations come to maturity, the Don Cossacks

[1] Cossack village.

will contribute to the active army a force of upwards of 50,000 completely equipped cavalry and 22 horse artillery batteries, with 132 guns. Besides these, to replace casualties, there will be a reserve of 20,000 to 25,000 men, the oldest class of the *preparatory* category, 5,000 to 7,000 men, and the militia, consisting of 25,000 to 30,000 Cossacks.

Formation of the Crimean and Bashkir Divisions.

The object of these new formations is to have a small permanent establishment for training recruits, the Crimean division for the Tartars of the Crimea, the Bashkir division for the Bashkirs (Tartars) who live within the jurisdiction of the Orenburg Government.

At first only squadrons were formed, but the contingent was afterwards increased to a division of two squadrons.

The Bashkirs had at one time a regular force, which was afterwards disbanded. By the present arrangement, instead of being subject to the new military law, they satisfy their obligation to military service by forming a separate contingent, very much in the same way as the Cossacks. They provide their own horses and equipments.

Additional Formations in Turkestan.

In consequence of the recent operations undertaken against Kokan, and the resistance which was experienced, it has been found necessary to form two new line battalions of infantry and a battery of artillery in the Turkestan military district.

We now come to the more important reforms which have taken place in the administrative branches of the army.

Reforms in the Administrative Branches.

The change of the greatest moment is the reorganisation of the local military administration in the Governments and Circles (*Vyezd*),[1] viz., those local authorities charged with the recruitment of the army in time of peace, the accounts and control of the recruits, and more especially, the mobilisation of the army in time of war.

The control of the reservists in time of peace devolved formerly upon administrative authorities of two instances. The highest instance for each Government was the bureau of the military chiefs of Governments, the lower instance, for each town or Circle, was the town and Circle police administrations. The control of the first instance was merely nominal. The real work fell upon the shoulders of the authorities of the lower instance, consequently upon civil administrations which were already overburdened with their own business, and therefore inclined to look upon the duties connected with the reservists as of secondary importance. The military chiefs of Governments kept up registers of the reservists based on the information furnished by the police, but without any knowledge how far the information thus supplied was in agreement with the true position of

[1] In Russia the empire is divided for administration purposes into Governments, and these into *Vyezds*, or Circles.

affairs. At the same time, when the number of reservists was comparatively small, there was less necessity for a specially constituted administration, but of late, when the number of men on furlough is said to exceed 700,000, the old arrangement was no longer sufficient. With the introduction of obligatory service, when the number of reservists will, in course of time, be still further augmented, it would have been utterly beyond the power of the old administration to carry out the duties.

Again, all the arrangements for calling out the reservists in the event of mobilisation were too much centralised, being centred in seventy Government administrations. The former military chiefs of Circles formed merely a superfluous channel between the police and Government administrations, and, consequently, rather retarded than accelerated mobilisation.

In the present day a military official has been introduced under the Government Military Commander, as a lower instance, called the Circle Commander, who is the real executive authority in regard to recruitment and the control of the reserves.

The duties of this officer are as follows:—He exercises direct command over the local troops in the garrison where his head-quarters are established and has the general control of all the other local troops within the circle. He is a member of the Circle Recruiting Commission, and as such is personally responsible for the selection of the recruits for the various arms. The duty of keeping the registers of the reservists and of the militia of the 1st class, as well as of the reserve officers and men intended to be assigned to form the cadres of the reserve and depôt battalions devolves upon him. On the basis of the lists furnished by the general staff he apportions the reservists to the troops and prepares beforehand their joining orders, so that no time may be lost on the mobilisation of the army. He is responsible for the stores at the depôts being provided with the clothing, equipment, &c., necessary for the reserve and depôt battalions to be formed in his Circle. It is his duty also to collect such information and statistical data as bear upon a rapid mobilization in the Circle, so far as they affect the distribution, supply the roads of communication, and the means of transport. In time of war he calls up the reservists to the colours, dispatches them to the field army and fills up the local troops under his command. He forms the reserve and depôt companies and issues orders for them to join their respective battalions. He makes arrangements for transport of the sick and wounded, and for putting in execution, within the Circle, the law with regard to the compulsory supply of horses on mobilization.

Whilst the Circle Commander is the executive authority, the Government Commander exercises general supervision over the Circle Commanders. Superior to him again is the Commander of the Local Troops of the Military District.

This augmentation of the administrative authorities who have the important duties of controlling a number of men, who after passing through the the Army are living in the mass of the population, and have to make such arrangements as will ensure their timely assembly

on the receipt of the orders for mobilization, is of great moment. In a vast empire like Russia, it would have been impossible to do this effectively with the seventy Government administrations, the Governments often embracing an area of hundreds of square miles. The distribution of work requires to be on a much larger scale. Hence the introduction of the Circle Commander as the executive authority.

It seems that even this distribution is hardly sufficient, and that it requires still greater extension. For instance, in North Germany, the same duties devolve upon 70 commanders of brigade districts, 296 commanders of landwehr battalion districts and 1,300 company district sergeants-major. The Russian circle commander corresponds to the commander of the landwehr battalion district in Prussia, so that the further link of the company district serjeant-major is wanting in the former country—and we know the value attached by the Germans to these officials in the control of the reservists in time of peace. It appears to us, that within certain limits, the more this nature of work is divided, the more effective the control over the reservists in time of peace, and the more speedy the mobilisation in time of war.

Another important reform was the issue of the regulations for the formation of army corps.

Formation of Army Corps.

Up to recent times the Division of infantry has been the largest unit of troops, one or more Divisions being quartered in each military district. In addition to the Divisions of infantry, there were Cavalry Divisions and Brigades of artillery in each district, but there was no intimate grouping of the different arms such as we understand by the army corps, which consists of a due proportion of the three arms accustomed to work together.

The question of the formation of army corps was discussed as long back as 1870, by the commission appointed to consider the re-organization of the army, but the opinions were so divided that no conclusion was arrived at, and the question was left for the final decision of a special commission. The result of their labours was to recommend the partial introduction among the regular troops of army corps, regulations for which were confirmed by the Emperor in August, 1874.

In these regulations it is laid down that in those military districts in which the troops are to be grouped in army corps, the officer in chief command of the troops in the district has the right of inspecting the corps personally or through the chief of his staff. It is also his province to see that the service duties are carried on in a proper manner, that the troops are well and duly supplied, and that all the material required on mobilization is held in constant readiness for use. In those districts where the formation by army corps does not obtain, the duties ordinarily devolving upon corps commanders fall upon the officer in chief command of the troops in the military district.

The duties of the corps commander comprise the command of the *personnel* and the military training of the Corps. He is under the

immediate orders of the officer commanding the troops in the military district. Upon him devolves the duty of deciding as to the manœuvres of the year, and exercising general control over them, determining what troops are to be encamped and so forth. He makes an annual inspection of the troops at the time he thinks fit to appoint, rendering to the officer commanding the district a report of their state and more especially with regard to those matters which affect mobilization, for the rapidity of which in time of war he is personally responsible.

Up to the present time the administration by army corps has only been applied to the Guard Corps, which has been formed under the command of His Imperial Highness the Tsarevitch.

From the preceding brief sketch of the various reforms which have been introduced in the military system of Russia, it will have been seen that the chief objects sought to be attained are a sufficient reserve of men on furlough to fill up the peace cadres, an intimate connection between these men and the regiments they are designed to complete, and the adoption of such arrangements as will tend to their rapid assembly round the standards, in other words the mobilisation of the army for war.

No nation which respects its independence, be its geographical situation what it may, but must attentively consider these matters beforehand in peace, and work out and mature the scheme of mobilisation best suited to its peculiar requirements, no matter at what cost. The sound of the war-tocsin—the day of the declaration of hostilities—is no time for considering in what way the various units shall be grouped, but must merely be the signal for setting in motion those agencies, carefully pre-considered and rehearsed in time of peace, by which the army is placed in the field as a perfect weapon for offence.

HUGO HELVIG'S TACTICAL EXAMPLES.[1]

I.

THE late campaign in France has caused a very curious change in the general impression concerning German intellect. Formerly, they were considered to be a slow and plodding people; now men speak with respect of their dash in war, and argue that such brilliant strategists, tacticians, and leaders of troops, cannot be deficient in brightness of intellect. A little examination of the subject, however, soon shows that the facts are as were first supposed, only the inferences drawn were erroneous. We may look through the whole war in vain for examples of the inspiration plainly displayed by Napoleon I. In 1870 was shown the power, not of genius, but of sober systematic organisation and training joined to a stern discipline. The only brilliant idea struck out of German solidity of character was the pamphlet written after 1866, and attributed to Prince Frederick Charles, in which the author pointed out that to be successful against the French it would be necessary to meet them with their own tactics, not to wait for their rush, but to attack boldly. Yet even this idea, fertile in success as it turned out to be, may have been elaborately thought out. Who knows how many months the author may have pondered, how many hours he may have spent with his leaden battalions and Kriegsspiel maps before the pamphlet was published? Prince Frederick Charles himself once told the present writer that he attributed the great success of the Prussians, even against superior forces and equal bravery of the French, to that admirable system of instruction which enabled generals to trust absolutely in junior officers, knowing that the shortest and simplest orders would be enough for them, and that wherever an officer was present, the troops he led would be handled on certain definite and well understood principles. Though the German drill-book was in its regulations behind the age, the German Officers were able to direct their men to victory while breaking the rules every day and every hour. Since the war, there have been serious controversies little heard of in England. The drill book has been altered, but is still, in the opinion of a large school of tacticians, quite unable to meet the requirements of modern war. The author of *Tactical Examples* writes in the spirit of the new school. He will not allow his book to be considered as an addition to the regulations, though his examples are worked out in conformity with the present

[1] Tactische Beispiele von H. v. Helvig (Major) : Mittler, Berlin. 9*s*.
"Exemples Tactiques." Par H. v. Helvig, Major de l'Etat, Major-General Bavarois, détaché au Grand Etat Major-General Prussien. Traduction de M. le Lieut-Colonel Lectère. Paris, 5*s*. 6*d*.

formations. On the contrary, he insists that "it is not *with*, but in "spite of the regulations, that *good instruction* and *solid* preparation "for war, as the author understands them, are possible in time of "peace." His teaching is based on the venerable principle, "The "letter killeth, but the spirit giveth life." True, he could not have worked out these examples in their present form if the drill book had not been altered, but he holds that the regulations alone would not only be insufficient, but positively detrimental. He insists with much truth that there is no formation which will meet all cases, that officers must be trained to act according to circumstances, and that as the necessities of modern fighting inevitably cause more confusion than occurred of old, the highest wisdom now is to practise that very confusion, and the means for extrication from it, rather than to insist on a steadiness in peace manœuvres which must break down in war. Let not the lover of steadiness and discipline start back in surprise and condemn the book unread. Its object is to reduce to a minimum the real confusion in war by familiarising officers and men with the difficult situations likely to arise until confusion is no longer real, but only apparent.

Von Verdy du Vernois, in his "Studies on Troop Leading," gave the world admirable examples of the movements of divisions and brigades under circumstances supposed to be those of war itself. Major Helvig undertakes the more modest, but not less useful, task of working out in detail the manœuvres of smaller bodies, companies, battalions, and at last brigades, under different given conditions; and he recommends strongly that all commanding officers should train their commands by exercising them in the examples he gives, or in others devised by themselves. So anxious is he to imitate closely the difficulties of war, that he even proposes that, at various stages of the fight, leaders of different bodies, battalions, companies, &c., shall be caused to step out of their places as if wounded, and resign the command to subordinates. By such arts as these will he have war simulated, and officers trained in the new tactics now accepted by all the world, so that the praise of Prince Frederick Charles shall still be deserved, and Generals be able to count on the cool action of their juniors, even when all seems to be a mass of confusion.

The first volume contains thirty examples, the highest of which shows only a force of one battalion, two squadrons, and a few guns. The second volume begins with a battalion and a-half, and ends with a brigade of seven battalions, together with three batteries and four squadrons, forming the rear guard of a large body of troops, and ordered to defend the passage of a defile. His method may perhaps be best described by taking one of his simplest examples, and working it out with him. For this purpose nothing can be simpler than one battalion on either side, and we will take Major Helvig's first example. The real student of tactics will not despise even first lessons. We can assure him that he will find further on in the book examples of a much more complicated character.

Our example, then, is the attack of one battalion against another, each consisting of four companies.

The author begins by laying down certain tactical considerations for each example; and the "considerations" with regard to the one we have chosen are that, with equal forces on both sides the enemy should be "contained" in front, whilst the principal attack is directed against one of the flanks. Premature and insufficiently prepared attacks from the enemy are to be repulsed by as rapid a fire as possible, whilst the reserve, held in readiness, endeavours to profit by seizing such moments for counter-attack.

The battalion is advancing in company columns at deploying intervals.

Major Helvig gives the condition of the fight at twelve different phases, which he calls first, second, third, &c., moments. A diagram is given for each moment.

First moment.

No information as to the position or strength of the enemy has yet been received; he shows only some infantry patrols. The battalion is to advance, and throws forward the 4th company as advance guard.

The diagram shows how the company advances, half in skirmishing groups, half in support.

Second moment.

The point of the advance guard comes in contact with the enemy's skirmishers; in rear of them are seen subdivisions in formation.

The 4th company deploys its remaining two sections, and drives in the skirmishers by a vigorous attack; left flank advanced, in order to discover the position and strength of the adversary.

3rd company doubles forward, to act as reserve to the line of skirmishers.

1st and 2nd companies follow as main body.

Here we are struck at once by the regularity with which all such manœuvres are carried out in Germany. In them, as in battles, there is no such thing as the advance of a long thin line, whether skirmishers or otherwise, without supports. A force, however small, retains depth as well as breadth, until actually in contact with the enemy, and then, in almost every instance retains a reserve. We shall have to speak of this question further on.

Third moment.

The enemy checks the march of the 4th company, by a superior fire of skirmishers, and taking the offensive against the left flank, repulses the 4th company.

The left flank of the 4th company is thrown back so as to form a defensive angle with a section in formation close to the point; skirmishers on the left.

The 3rd company 200 paces behind the left wing faces the out-flanking enemy as a support.

Fourth moment.

The enemy continues to press the left flank and, at the same time,

advances against the front. His strength is now known; he has two companies attacking in front and two attacking the left flank.

The 3rd company moves up to the left flank, not prolonging the wing as thrown back, but inclined at an angle to it, so as to threaten the flank of the enemy's advance. One section is deployed as skirmishers, the other two remain in formation to fire volleys.

The 1st and 2nd companies move up rapidly.

Fifth moment.

The fire of the left wing has checked the enemy; but, meanwhile, he has pushed forward in front with one company in skirmishing order and one in formation.

Hereupon the 1st company moves to the front in skirmishing order:

Hereupon the 2nd company halts and forms line as support.

Rapid fire is ordered.

Sixth moment.

The enemy slowly draws back his right wing which he had advanced, and takes up a position in front with two companies in skirmishing order and the companies in formation.

The 4th company advances from the left wing, group by group, up to the line occupied by the 1st company. Each of them have two sections in front skirmishing, and one in support.

The 2nd and 3rd companies form company columns as a reserve.

There is no need to follow the author through the next four movements during which the enemy makes a front attack, and is beaten by the employment of the 2nd and 3rd companies in a flank counter-attack. Sufficient has been given to show the style and scope of the book. But we may examine with profit some of the maxims laid down by the author and the methods of handling troops proposed by him. It is often justly said that the science of tactics is only that of common sense. But how long has the world required to arrive at such growth of common sense as now seems simple to some people? Not even yet for all. So is it with the tactical considerations laid down by Major Helvig. They are based on common sense, yet without help any Officer would spend a campaign in working them out for himself. No amount of ordinary drill even when combined with general maxims can teach the handling of troops *in answer to the movements of an enemy.* For instance, common sense and all the books teach that infantry should keep a reserve ready for emergencies. Yet there are times when the whole force must be sent in to win, every man being pushed forward into the attacking line. Here is a question which neither drills nor books can answer. It must be settled on the spur of the moment, and the only good preparation for the time of decision is the habit of handling troops in the field under conditions approaching as nearly as possibly those of war. But, to take an officer fresh from common drill and place him suddenly in charge of a body of men manœuvring against another force is to task his resources unfairly and probably to injure his style of tactics. Some intermediate steps are

required similar to the exercises which a fencing master gives his pupils between the teaching of thrusts and parries, and the final loose practice. Moreover, the *maître d'armes* brings his pupil back again and again from loose practice to steady lunging and parrying by order, to strengthen his wrist and steady his eye. These examples of Major Helvig are just the intermediate practice required in tactics, and we have no hesitation in saying that the book supplies a very pressing want. With Major Helvig's examples in his hands, no commanding officer can now have any difficulty in teaching his subordinates the science of tactics.

The first point that fixes the attention, among a multitude of details, is the method of handling infantry for attack and defence, so as to develop the full power of breech-loaders. Major Helvig makes full use of the swarm formation, which, after much controversy, has been admitted as the latest method of infantry fighting, and he shows how adaptable it is to circumstances. For we are not to imagine that infantry so broken up into skirmishers are always to remain so. On the contrary, one of the most valuable features of the new formation is that the fighting line admits of contraction as well as expansion, and can be reinforced, from supports and reserves, without in any way altering its character or deranging its action. In looking through Major Helvig's diagrams, we find his battalions invariably kept in hand at first, then follows the fan-like spread, including first skirmishing line, supports, and reserves; then occasionally, at critical moments, a pushing of the supports, or even reserves, into the front line, sometimes in skirmishing order, sometimes with serried ranks to fire volleys. We find the front line itself changing its character from moment to moment. Now it consists of skirmishers only, anon, threatened by cavalry, it collects in groups or rallying squares; again, it dissolves when the cavalry are repulsed, and is presently reinforced by the coming up of all supports and reserves, some of them extending or thickening the chain, others strengthening its powers of cohesion by more solid links. But, in all cases, as soon as the action is decided, even for a time, the moment of relief from the enemy's pressure is seized to re-establish order and re-form the battalion. This practice of pulling the troops together as often as possible is highly necessary as an antidote to the natural tendency to disorder, which is the one weak point of the new tactics. If it is not taught and insisted on, from day to day, nothing will save infantry from confusion, and we may come to see battles lost by reckless charges and pursuits pushed beyond reasonable limits, like the famous charge of Prince Rupert's cavalry. By such practice will also be corrected the inclination of the skirmishing line to disappear in the centre and stream round both flanks of the enemy, and another tendency, almost equally injurious, to occupy too much space of frontage without supports or reserves. No soldier who has seen the swarm system of tactics carried out, either abroad or at home, can doubt the reality of these dangerous tendencies or deny that they must be provided against by careful instruction, just as the soldier, armed with a breech-loader, must be taught not to waste his ammunition.

The next important feature of Major Helvig's teaching is the frequent and bold use of cavalry, and the success he allows them—not a success, so far as to inflict positive defeat on infantry, but to waste the time of an enemy, and oblige him to desist from prosecuting his present purpose. The chief value of the book is its evident impartiality. Each arm plays a part in his examples, fairly proportioned to its power under the circumstances, and there are no exaggerated views as to the action of infantry, cavalry, or artillery. If the balance inclines at all, it is to the side of the infantry, and this is no fault. Without question no encouragement given to another arm could compensate for the discouragement of infantry if it were taught that it must constantly yield to the fire of artillery or the charges of cavalry, and we hold it advisable during peace manœuvres to give less than the true value to the power of artillery fire, while encouraging batteries to act with bold decision. But in these days cavalry also requires some encouragement and should be caused to execute charges against infantry more frequently than is now the custom. For, in truth, infantry fire is not the deadly thing on a battle-field that it appears to be on the practice ground, and a plucky charge of cavalry will often turn the scale if balanced or even inclining the other way. Take Major Helvig's twenty-seventh example at the seventh moment. Our force is one battalion and a squadron against one battalion and a-half of the enemy, who have deployed a chain of skirmishers which is already superior to ours in number and seems about to envelope our left flank. Our squadron charges his left, and under cover of the confusion so established, we push forward two companies hitherto in reserve and so outflank the enemy's left, forcing it back with ease, because we caught it prepared for cavalry, not ready to combat the fire of a line of skirmishers. Everybody acknowledges that a first-rate cavalry leader is very hard to find, seeing that he must possess certain natural qualifications not often found united. But every cavalry Officer might be brought up to a moderately satisfactory mark by such practice as these examples of Major Helvig, not reading them merely in his pages but working them out on the ground with a marked enemy, as steadily as he would execute parade movements. We would insist strongly upon the fact that the "tactical examples" are not to be treated as competitions between one Officer and another, but as a higher and more practical kind of drill than that, the sole end of which is attained when the men are sufficiently in hand, and the Officers expert enough to perform a few simple movements in preparation for tactical practice. The "examples" can be worked out even in a barrack square when no other drill ground is available, but we would advise the use of drill fields whenever they are available. No accidents of ground are necessary, for such as are spoken of in the "examples" may be marked in the same way as the enemy is to be marked, and the same example may be worked out two or three times in succession with such modifications as occur to the minds of the Officers. And another valuable point about Major Helvig's book is that it will afford to teachers of tactics (and all commanding Officers even of companies should be teachers), a large stock of questions to be put to those

whom they are bound to train. A general and well-founded complaint during autumn manœuvres, or the manœuvres of small bodies, as now practised with so much success at Aldershot, is that the fire of artillery cannot be truly estimated, because no one can tell what the guns a mile away are covering with their fire at any particular moment. In Major Helvig's examples there is no such difficulty. You are told that the artillery is firing heavily at such and such a mark, and you can decide on the course to be pursued, just as you would if your men were actually falling and becoming demoralized.

To attempt an examination of all Major Helvig's examples would be to write an essay on modern tactics, but we may, by analysing two of them—an attack and defence—get fair hold of the author's main ideas on the handling of the three arms in concert. For this purpose we will select Nos. 52 and 53 from the latter part of the second volume. No. 52 is the action of a brigade composed of 4 battalions, with a battery and 2 squadrons attached to it, the whole forming part of a division in an offensive action.

The "tactical considerations" supplied by the author, lay down certain rules, the first of which appears to us somewhat self-evident. It is that when detachments of cavalry and artillery are attached to a brigade of infantry for certain moments of a battle, they ought to be employed exclusively to attain the object set before the brigade; but the rules for such employment are practical and worthy of notice. Major Helvig says that a battery attached to a brigade to support the execution of an attack should exert all its power to facilitate the mission. It should direct its fire solely on the point which is to be pierced, that point being distinctly indicated to it. It must never answer the fire of the enemy's artillery. Just before the assault it must advance—at its own initiative—to whatever distance may be best for the efficacy of its fire. When the position is taken and the enemy retreats, the battery must push on without hesitation in pursuit. If the attack fails, the guns must hold their ground to the last extremity, in order to assist the defeated infantry to halt speedily and re-form to repulse the pursuit of the enemy.

The cavalry must watch from a distance the flanks of the attacking force which might be menaced, oppose without orders or hesitation every attempt at counter-attack, and, in order to utilize success, attack also without orders or hesitation any part of the enemy which seems to be wavering, so as to enable the infantry to continue its fire from the conquered position as long as possible, and help the companies or battalions sent in pursuit. Here we have text enough for a long tactical sermon, but must leave our readers to ponder over the matter for themselves.

The brigade forms part of a division engaged in fierce fight with the enemy, but has not hitherto borne the brunt of the action. The commander of the division decides to attack the enemy's right wing, and reinforces the brigade with a battery and two squadrons. His orders are given in these words: "I have information that the enemy's "reserves are marching against our left wing. The second brigade "will attack the right of the enemy at the point A (farm, local posi-

" tion, wood, &c.), retaining a regiment as a general reserve behind his " left wing. The two squadrons, which are observing the left flank, " and the battery which has just arrived, are placed under the orders " of the brigade. Hasten the attack."

This is a thoroughly typical example of the orders given by German Generals of Division, who would as soon think of directing how the brigade was to advance as they would of saying to the Brigadier, "It " is going to rain, turn up the collar of your great-coat."

The General of Brigade hereupon sends the following order to Officers commanding regiments and battalions, as well as to his new adjuncts, the battery and detachment of cavalry.

" Reinforcements of the enemy are marching against our left wing; " the brigade is to carry the point A."

" Regiment No. 2 will execute the attack."

" Regiment No. 1 will remain provisionally in general reserve, and " follow, extending beyond the left wing."

" The cavalry will watch with its scouts the approach of the enemy, " will hold him back if possible, and charge as soon as the attack of " regiment No. 2 has succeeded."

" The battery will prepare the attack energetically, taking up a posi- " tion to the left front."

" I am to be found with the principal line (regiment No. 2.)"

We commend these orders to the attention of our military readers as containing everything necessary, yet leaving room for plenty of initiative on the part of the various commanders, who must, however, be well trained men to be so trusted.

The enemy observes the advance of the brigade, and immediately directs upon it a heavy fire of artillery. Regiment No. 2 has disposed its first and second battalions as first and second lines, the first being skirmishers with supports and reserves, the second company columns. Regiment No. 1 advances with its two battalions in echelon from the right, both in company columns.

The enemy's right wing appears to be reinforced and a hot fire issues from it. Regiment No. 2 sends up the reserves of the first battalion to the fighting line in prolongation of the left, and supplies their place with half the 2nd battalion. Regiment No. 1 sends up its 1st battalian at a double beside the second half of the 2nd battalion. Two columns are now seen advancing in the distance, one to join the right wing of the enemy, the other to attack our left flank. Thereupon Regiment No. 1 occupies with its 2nd battalion a position on the left flank, while the rest of the brigade push on towards A. The attacking line, reinforced by half of the 2nd battalion, which moves up in prolongation of the left wing, and at 400 paces from A, begins to envelope the enemy's right. The battery pushes on to within 1,000 paces (800 yards) of the enemy's position A. The cavalry detaches half a squadron to assist the part of the first regiment occupying the position in flank, the rest of the horsemen continue their forward movement with the attack.

The enemy accelerates the march of his right column and deploys in skirmishing line all the troops in the position A. Regiment No. 1

sends forward part of each company of its 1st battalion as skirmishers. These and the 2nd regiment advance against A. Our cavalry charges the enemy's advancing right column, which is stopped by the charge. The other column of the enemy also hesitates and appears inclined to retreat. The whole of our forces advance rapidly, and the position is carried, but the column of the enemy which was checked by the cavalry again advances with clouds of skirmishers towards our left flank.

At this stage Major Helvig sends to the rear as wounded, two battalion commanders, six company leaders, and six subalterns. Regiment No. 2 occupies the captured position and regiment No. 1 sends both its battalions against the flanking column, upon which the battery opens fire. The cavalry concentrates near the battery. The column retires, but the enemy has gained time to retire in good order.

The brigade is ordered to occupy the position and defend it to the last extremity. It forms in good order with the battery on the left of the skirmishing line. The cavalry press on to the front to reconnoitre.

In this example we see employed in the fighting line of skirmishers at the critical moment the whole of the 2nd regiment, except two companies, and a section of each company of the 1st battalion, 1st regiment. We see the cavalry delaying the advance of the enemy's re-inforcements by charging them boldly, and the battery pushing on to within 800 yards of the enemy's position, the whole force being used with decision and energy. Delay might have been fatal to success, for the re-inforcements might have joined the enemy and made him too strong to be resisted.

In the 53rd example a similar force, namely, four battalions, one battery, and two squadrons, form part of a division in a defensive action. The author again insists that the artillery and cavalry are to act solely with regard to the present emergency. The artillery is to fire at the advancing infantry of the enemy, and on no account allow itself to be turned from this object whatever it may suffer from the enemy's artillery. It must endeavour to cover the hostile infantry with projectiles, flanking it, if possible, and especially that flank which is likely to be the objective of a counter-attack. If the orders are to hold the position at all cost, or if the general situation demands, the battery must on no account seek safety in retreat, but continue its fire even if the enemy are at the very muzzles of the guns. Major Helvig says with great justice, "The abandonment of the defensive position "by artillery is from a moral point of view the first half of defeat for "the infantry, and half a victory for the assailant."

The cavalry must be constantly watching and gaining information, and then assist and render more energetic the counter-attack. It may possibly have opportunities for short counter-attacks even while the brigade is still on the pure defensive, but must beware of prematurely expending its material and moral strength, lest it should not be available for the counter-attack. Above all, it must bring to an end, as quickly as possible, all uncertainty as to the disposition and force made by the attacking enemy; by that means it will fulfil the important mission of enabling the General of brigade to decide where

and how his counter-attack ought to be made. The brigade is in order of march with the usual advance guard, consisting of one squadron, one battalion, and two guns. We may observe here in passing, that the Germans hold fast to the idea of very strong advanced guards, in this case nearly a third of the whole force. The point of the advanced guard sends back word that a strong column of the enemy, composed of all arms, apparently about a brigade, is approaching. At the same time, the Commander of the division sends orders for the brigade to occupy as quickly as possible the position A B, and hold it until the second brigade has passed a defile, and is able to take the defensive. The brigade Commander halts the advance guard, and tells it to occupy the left of the position with its squadron and two guns outside the left flank. The first battalion of the main body places itself on the right of the battalion of the advanced guard. The rear regiment is ordered to occupy the right of the position, but this disposition is shortly afterwards changed. The four guns of the main body are pushed rapidly to the right front of the position; the cavalry of the main body outside the battery. Thus, in fact, each body of troops is sent to occupy the part of the position nearest to it. But the enemy now opens fire from a battery against the left wing of position, and seems to be re-inforcing his right wing. The brigade Commander evidently thinks that his left is threatened. He halts one of the battalions of the rear regiment, holding it ready until he is certain, and sends two guns from the right to the left flank. The cavalry dashes out to get information, with orders not to attack. It brings back word, that the enemy, who is now deployed, shows four battalions on his right wing. Upon this the 2nd regiment, which is in front, brings up its reserves into the fighting line. The first battalion of the 1st or rear regiment sends three of its companies to act as reserve for the 2nd regiment, and throws one company into skirmishing order on the left to guard the flank of the guns. The other battalion is brought up to act as general reserve, 300 paces behind the reserves of the fighting line and near the left flank.

We have now arrived at the 4th moment when the enemy begins to envelope the left wing. The 2nd regiment which is in the first line throws back its left flank, and the guns are withdrawn gradually, without limbering up, into line with the infantry. The general reserve battalion wheels a little to its left, and moves up so as to be 300 paces behind the left flank of the front line. The enemy continues to develope his attack against the left wing, and the brigade Commander orders his general reserve to make a counter-attack breaking out from the left flank. The cavalry is ordered to attack also, the rest stand fast. The enemy's attack is checked, but so is the counter-attack and the battalion which made it, has to fall back again with serious losses. At this stage Major Helvig sends to the rear two battalion Commanders, four company leaders, ten subalterns. The battalion which has made the counter-attack is sent rapidly to the rear to rally behind the left flank. The cavalry rallies behind the battery.

By this time the 2nd brigade of the division has passed the defile and begins to make its presence felt by the enemy, who retires slowly

without giving opportunity for another serious action. Our left flank which had been thrown back is advanced again, the battery also moves forward and plies the retiring enemy with its fire. The infantry is assembled, one regiment occupies the position, the other in reserve. The second brigade pushes on, and the one whose movements we have followed, is ordered to rest for a while in the position it has defended.

Now, if all this is not actual war, it is at least as clear an imitation of it as is possible during peace, and familiarity with such exercises may, with great advantage, be made to precede and alternate with manœuvres against actual troops with opposing Commanders; at least no one can say that practice so systematically conducted can lead to unsteadiness in the field.

We hope we have said enough to show the thoroughly practical character of Major Helvig's book and its value, not only to professed students of the military art, but to all Officers as a means of self-instruction and a hand-book from which to instruct others. We have now to draw attention to the fact that the volumes were written by a Bavarian Officer attached to the great general staff at Berlin, and translated or at least published by a similar organisation in Paris whence issue continually excellent works, translated or original, and published at very moderate prices. Some of the best intellects in the German and French Armies are employed on such duties, for it is recognised that the distribution of information is one of the legitimate and most valuable functions of a general staff. May the day soon come when Officers of the English Army will not have to hunt through foreign catalogues for such books as this, nor be left in doubt as to the value of them since their names alone can be taken as an index of their contents. An Intelligence Branch has been added to the office of the Quartermaster-General as a sort of nucleus for that General Staff, which is at least as necessary for England as for foreign countries. Is the establishment always to remain at its present inadequate strength, and are students to be thrown back upon private enterprise for all hope of reading in their own language, books of the greatest importance, but not likely to bring in a profit to any firm of publishers? In saying this, we do not undervalue the excellent work which has already been achieved by the Intelligence Branch. We ask for more of it, and more officers to execute it. The fact that it has done so much is the best argument for asking that it may be given power to fulfil the duties entrusted to it. Among those duties none is more pressing than the diffusion of military information by means of the printing press.

THE NEW FRENCH RIFLE.

(Condensed from the *Revue d'Artillerie*, Feb., April, 1876. By Captain R. A. E. Livesay, R.E.)

The Chassepot, under the official designation of rifle of pattern 1866, was, as is well known, introduced into the French service in that year. Its manufacture was then actively proceeded with; and on the outbreak of the war in August, 1870, about 1,200,000 had been finished. The French fought the campaign of 1870 and 1871 chiefly with it, when its good and bad qualities were thoroughly recognised.

At the close of the campaign, the French Minister of War ordered an inquiry to be held as to the manner in which the Chassepot of 1866, as well as its cartridge, had acted during the time they had been in the hands of the troops. This inquiry was made, and brought to light the necessity of making certain improvements in the arm, and more particularly in the cartridge.

The cartridges, like those of the Dreyse rifle, are self-consuming, and as such, their advantages are (1) simplicity in the breech-mechanism of the rifle, a cartridge extractor not being necessary; (2), small relative weight of cartridge-case. These great advantages are, however, accompanied by serious defects in reference to transport and self-consuming power; the cartridges ought to be sufficiently durable not to deteriorate when transported, either in large or small quantities, and burn away completely when the rifle is fired. These conditions are to a certain extent contradictory, and up to this time have not been completely fulfilled; and consequently the disadvantages inherent in the cartridge showed themselves quickly on service. The cartridges were not sufficiently durable, and particularly those carried by the soldier soon deteriorated; also the residue in the chamber after each discharge accumulated to such an extent as to lead to difficulties in the way of charging the rifle after a number of rounds had been fired. Besides these great disadvantages, there were other minor ones, and it was with a view to do away with or minimize them all, if it were possible, that the Vincennes Commission of the 3rd Sept., 1872, with General Douay as president, was formed.

The attention of this Commission was at first directed to certain proposals brought forward with a view to improving the self-consuming cartridge of the Chassepot rifle, 1866 pattern; but the Commission soon recognised the extreme difficulty, if not the impossibility of producing, within a reasonable time, a self-consuming cartridge which

would not necessitate changes in the rifle, and they expressed their opinion that the best plan would be to substitute, for the self-consuming cartridge, a metallic one.

With a view to this substitution, many propositions had been made since 1866; but there were practical difficulties; as in the Chassepot the cartridge was placed at a considerable distance (1·4 inch) from the end of the chamber, it would be most difficult to adapt to the breech-mechanism an extractor which would easily remove a metallic cartridge occupying a position so far in as the self-consuming cartridge did; there would not be, it is true, much difficulty in the case of those rifles still in the workshops, in which the cartridge-chamber had not been as yet formed, and the rifles in hand could be provided with new barrels, but such a substitution, in the latter case, would be a heavy business; it was then proposed to try and effect the necessary modifications by boring out the old chamber and inserting a new tube adapted to the metallic cartridge. A number of trials as to the best practical method of re-tubing the old rifles were then carried out; many gave satisfactory results, and the Commission arrived at the conclusion that the re-tubing could be successfully adapted to a metallic cartridge; many proposed methods of firing the cartridge were also considered, which were more or less good, according to the cost of transformation.

It was next considered necessary to examine into the question whether the manufacture of new rifles should be carried out according to the plan adopted for the alterations of the old rifle, or whether a rifle, original in all its parts, should not be adopted, the old rifle being altered according to a simple and expeditious plan. This double question was carefully and laboriously gone into, and it was decided that if a method of conversion sufficiently good for a new rifle was hit upon, new arms should be manufactured according to the plan adopted. Although by this decision the difficulties of the problem were somewhat increased, the question of unity of armament had such weight with the Committee that it mainly influenced their decision. In spite of the practical difficulties of the question, this decision of the Committee must be looked upon as a happy one, as in consequence the rearmament of the troops can be proceeded with rapidly, and the delay consequent on the introduction of an entirely new pattern rifle avoided, during which delay, the manufacture of rifles of the old pattern would have to be proceeded with, and these would have, later on, to be altered. The Commission then continued its inquiries; it examined into the shape of the ball, the manufacture of the cartridges, and experimented on several descriptions, and finally adopted a cartridge of diameter at base of case = 13·8mm. = ·55 inches, and containing 5·25 grammes = 81 grs. powder.

Several descriptions of rifles were submitted to the Committee, but after the preliminary trials, two were chosen as fulfilling more nearly than the others the conditions laid down by the Committee, and in order to decide between these latter, an exhaustive system of trials was forthwith instituted.

These selected systems were 1st, the Beaumont, already in use in

Holland; 2ndly, that proposed by Mons. Gras, Chef d'Escadron in the French artillery.

The Beaumont system is sufficiently well known not to need a description here; and it would have to be modified for cavalry and artillery purposes; hence unity of armament would not be secured.

System Gras.—This system consists in re-tubing the barrel, re-placing the *breech block* by a new arrangement, allowing or the employment of a metallic cartridge. The spiral spring is, as in the Chassepot, the basis of the striking arrangement. By the system Gras, unity in the armament of the cavalry and infantry is obtained.

From the above it will be seen that the two proposed systems lead to a change in the breech-mechanism of the old pattern rifle, further, that the breech-arrangement of the Chassepot could be altered so as to be used in connection with a metallic cartridge, but it was not considered possible to utilize it by any transformation which would have been sufficiently satisfactory to be adopted as the model of the new rifle. This is mainly due to the fact that the metallic cartridge necessitates a considerable striking power, and in consequence a more powerful spiral spring, which cannot be manipulated directly, but requires a self-cocking or automatic arrangement; and finally the mechanism of the 1866 pattern was not adapted to limiting the projection of the striker beyond the extremity of the breech-block by an invariable quantity.

The two inventors having adapted their systems to the cartridge proposed by the Commission, the trials were proceeded with on a large scale in several corps.

Regulations were drawn up and approved of by the War Minister in November, 1873, to the effect that the trials were to be conducted by three regiments of infantry, one regiment of cavalry, and one of artillery; each regiment of infantry to receive 100 rifles (50 new and 50 converted), the cavalry and artillery, each 90 rifles (45 new and 45 altered). Each infantry rifle was supplied with 1,000, and each cavalry and artillery rifle with 500 cartridges.

These rifles were manufactured at St. Etienne. The new ones were provided with a sword bayonet (*épée bayonet*) having a leathern scabbard, the converted ones retaining the old pattern sword bayonet (*sabre bayonet*).

The arms thus provided were submitted to various tests equivalent to several years' continuous service, and corresponding as nearly as possible to the actual exigencies of a campaign.

With each rifle supplied to the infantry:—

(1.) 30 rounds were fired each day;

(2.) 500 rounds of snapping;

(3.) 130 rounds continuously without cleaning;

The object of the snapping being to test the breech-mechanism.

At the end of the thirty days' trial each rifle had fired 1,000 rounds of ball cartridge. The rifle was snapped 15,000 times. These figures represent approximately the number of shots, &c., fired by a rifle in five years.

In the artillery and cavalry each rifle fired:—

a Breech Chamber
b Moveable Head
c Cylinder
d Button
e Hammer

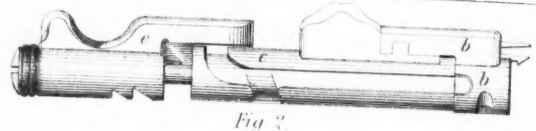


Fig 2.

Fig 1.

Fig 3.

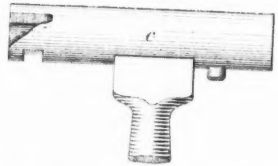
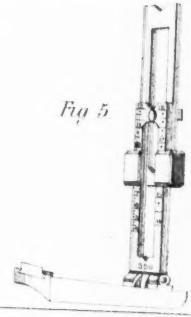


Fig 5



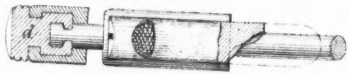


Fig 4.

J. Jobbins

Pl XII

(1.) 15 ball cartridges daily;
(2.) Was snapped 500 times;
(3.) And fired 75 rounds continuously without being cleaned.

Finally, during the last fifteen days of the trials, in each regiment, five rifles of each system were exposed night and day in the open air, and were employed in the trials without being taken to pieces or cleaned. In addition to the firing tests, the cartridges were specially tested in reference to durability, when carried in ammunition-waggons and in the men's knapsacks.

At the end of the trials, a report was made from each corps, and was forwarded to the Minister of War, who transmitted them, with his observations, to the Committee of Artillery, and finally to a Commission presided over by Marshal Canrobert. The conclusions of this Committee, which were as follows, were adopted by the President of the Republic, in an Order, dated 7th July, 1874.

The Commission recommended:—

(1.) The Gras system.
(2.) The new pattern sword-bayonet for the infantry (*épée bayonet*).
(3.) The modification of certain parts of the mechanism.
(4.) That the sword-bayonet (*épée bayonet*) be provided with a steel scabbard.
(5.) That the new arms on the Gras system be officially designated rifles, carbines, &c., 1874 pattern, and the converted ones on the same system, rifles, carbines, &c., pattern 1866–1874.

Infantry Rifle, 1874 Pattern.—The new rifle is like the Chassepot in appearance, but differs from it in the principle of the cartridge, as well as in the breech-mechanism. The rifle is provided with an *épée* bayonet, and its general dimensions, &c., in English measures, are as follows:—

Length of rifle	4·2804 feet
Length of sword blade	1·7121
Total	5·9925 = 6 feet.
Weight of sword bayonet	1·7632 lbs.
Ditto, without scabbard	1·2342
Weight of rifle	9·2568
Total weight of rifle and bayonet ..	10·4910 = 10 lbs. 8 oz.

The principal parts of the rifle are as follows:—

The barrel of the rifle is of cast steel, of the same shape and dimensions as the Chassepot. Its calibre is 11 mm. = ·433 inches; the total length of the barrel is 820 mm. = 32·29 inches; the rifled portion of which is 768 mm. = 29·92 inches; it has 4 grooves each 0 mm. 25 = ·01 inches deep, nearly; the area of the lands = that of the grooves, and the two are connected by arcs of circles of $\frac{1}{2}$ of an inch radius, the twist is right handed, and makes one complete revolution in 21·6 inches. The dimensions of the chamber of the barrel correspond with

those of the cartridge, so that when the latter is home, the point of the bullet is just at the entrance of the rifled portion. It is provided with a fore-sight similar to that of the old rifle, and the bayonet is attached to the barrel in the same manner. The barrel is screwed on to the breech, and a portion of its upper edge is chamfered off so as to allow the claw of the extractor to slip over it and catch behind the projecting edge of the base of the cartridge-case, when the breech-block is pushed home.

The Chamber (Figs. 1 and 2).—The breech-chamber does not differ much from that of the Chassepot. The general dimensions are pretty much the same with a view to uniformity of the new and converted rifle. The rear of the chamber has, however, been slightly modified, so as to maintain the anterior part of the breech-block firmly in the direction of the axis when it is drawn back or pushed forward. At the other end of the breech-chamber a small portion has been chamfered away so as to contain the extractor when it is pushed forward.

A projection or re-inforce above the upper surface, on the right hand side of the chamber, gives a firm bearing to the base of the lever, when the latter is turned down. Its anterior extremity is formed into a screw surface, so that while being turned to the right, the base of the lever slides on this screw surface, drives forward the breech-block, and locks tightly its movable head against the base of the cartridge, and brings the spiral-spring into its greatest state of compression. The breech-block is stopped when drawn back to its proper extent, by means of a stop-stud passing through the side of the chamber, and it acts in the same way as in the old pattern rifle. At the bottom of the chamber, near its posterior end, the head of the cartridge-ejector projects above the lower surface of the chamber, and tips up the end of the cartridge-case when the base of the latter strikes against it as the breech-block is drawn back. The main spring for discharging the rifle by pulling the trigger is fixed to the under exterior surface of the chamber, in the same way as in the Chassepot.

The breech-block (Figs. 1 and 2) is composed of seven pieces, as follows:—

(1.) The cylinder.
(2.) Moveable head.
(3.) Cartridge-extractor.
(4.) Striker or needle.
(5.) Spiral spring.
(6.) The hammer-button (*manchon*).
(7.) The hammer.

The cylinder (Fig. 3) serves to close the breech, its axis is hollow, and contains the spiral-spring which is wound round the striker or needle. The lever of the cylinder is attached to its upper surface. The base of lever fits exactly between the projections on the chamber, and so guides the cylinder when it is drawn back or pushed forward. When the lever is turned down to the right and the breech chamber closed, its end abuts firmly against the projection on the breech, to which, accordingly, the recoil is transmitted. In front of the lever and on

the side of the cylinder, is a projecting stud made to fit a corresponding groove in the movable head-piece (*tête mobile*) when the lever is vertical, so that the two pieces then become connected, and are moved backward and forward together. The exterior surface of the cylinder has two grooves cut on it; in the lower, the tip of the mainspring and the ejector-stud are contained when the lever is vertical, and the cylinder drawn back or pushed forward; the side one, in the same position, contains the stop-stud, and is curved off at its end at right angles, the rear curved portion is a screw surface similar to that at the end of the re-inforce on the chamber; these two grooves are connected by a transverse one, into which the ejector-stud passes when the lever is turned down and the breech closed.

At the base of the cylinder is a mortise (Fig. 3), the right hand side of which is formed into a screw surface; connected with the hammer is a projection similarly formed. When the rifle has been fired, these two surfaces are in juxtaposition, touching; the effect of turning the lever to the left is to make the screw surface of the cylinder slide on that of the projection on the hammer, and as this latter cannot rotate, the curvilinear motion of the cylinder produces a rectilinear motion of the hammer, which draws back with it the striker, thus compressing the mainspring, and so cocking the arm automatically. When the cylinder has been sufficiently rotated to the left, a small projecting stop-wedge attached to the hammer passes into a corresponding notch in the base of the cylinder, and the two are then connected. The cylinder is the only piece of the breech-mechanism which is capable of receiving a rotatory motion.

Moveable Head-piece (Figs. 1 and 2).—The object of this portion of the breech-block is to obtain a firm pressure against the base of the cartridge (for which purpose a recess in its fore part is made to fit exactly the base of the cartridge), and to contain the extractor. The front portion is cylindrical, and of the same diameter as the exterior diameter of the cylinder of the breech-piece; the hind part is also cylindrical and fits the hollow axis of the cylinder. Its axis is pierced to allow the striker to pass through, the fore part being circular and the hind part elliptical in section. The corresponding length of the striker is similarly formed, so that when the striker has acted, the moveable cap and striker do not move round with the cylinder when the latter rotates. On the outside are three grooves, the lower one to allow the ejector-stud to pass along, the lateral one, which in a certain position is in prolongation of the lateral groove of the cylinder, allows of the stop-stud passing freely, and finally a transverse one, which acts as a gas escape in case of the breaking of the base of a cartridge. On the upper surface of the moveable head-piece is a re-inforce or projection, the interior of which is hollowed out so as to contain the cartridge-extractor; on the right side of it is a mortise, fitted so as to receive the stud on the cylinder when the lever is turned to the left; then the cylinder and the head become connected, and when the cylinder is drawn back, the head follows.

Extractor.—The extractor is a spring composed of two arms with a stud on the upper, which connects it to the moveable head-piece. The

lower arm is provided with a claw at its extremity, which is intended to grip on the base of the cartridge. The extremity of the upper arm is sloped off so as to form an inclined plane, so that when the breech-block is pushed forward it slides freely into the cavity prepared to receive it at the top of the breech-chamber, at the same time that the claw of the lower arm passes over the base of the cartridge and grips it. By this forward motion the spring is compressed, and the moveable head piece is firmly fixed transversely.

Striker (Fig. 1) is a steel needle of 7 mm. = ·25 inch diameter, provided with a shoulder near its point, against which one extremity of the spiral spring abuts. The point is cylindro-conical, the portion of the striker between it and the shoulder of the striker being oval in section; in consequence of this particular form, when the striker has acted, it fits the corresponding cavity in the axis of the head, and when the lever of the breech-block is turned to the left, the striker is unable to turn with it. The other extremity of the striker is T shaped, and is fitted on to the button (*manchon*) that connects it with the cock.

The Spiral Spring (Fig. 1) is of steel spiral wire 1·5 mm. = ·059-inch diameter, making twenty turns in ·38 inches. One end of it bears on the shoulder of the striker, and the other against the opposite extremity of the hollow axis of the cylinder. When the rifle is cocked the compression of the spring = 29·6 lbs.

Button (Fig 4).—The button connects the striker with the hammer; it is a hollow T corresponding to that of the T on the striker, and is fixed to it in the same manner as in the Chassepot.

Hammer (Figs. 1 and 4).—The hammer is shaped like that of the old rifle, it is hollow and allows the end of the striker to pass through it, and to be made fast to it by means of the button (*manchon*), which fits into a cylindrical cavity at its end. The button passes freely in the direction of the axis, and is made fast to the hammer by giving it a quarter turn. Above the cylindrical portion, is the swell of the hammer, which projects in front of the cylinder containing the button, and guides the cock in the motions of loading. At the junction of the projecting and cylindrical portions, is a screw-surface corresponding to that in the notch in the cylinder, so that after firing, when the lever is turned to the left, the screw-surface of the notch presses on that of the hammer, and so pushes the hammer back and cocks the rifle. On the under surface of the cock there are two safety notches for the purpose of allowing the rifle to put on half-cock.

Action of the Lock Mechanism.—The stiffness of the spiral spring not allowing of the rifle being cocked by the thumb, the action of loading and firing is executed in four motions, as follows:—

1. Opening of the breech.
2. Introduction of the cartridge.
3. Shutting of the breech.
4. Pulling the trigger.

1. To open the breech, turn the lever from right to left, and draw back the breech-block until its motion is arrested by the *stop-stud;* during the first part of this operation several mechanical effects are

produced, firstly: the rifle is cocked, for when the lever is turned from right to left, the screw surface of the notch of the cylinder acts on that of the cock, and as this latter cannot turn, it is forced back, carrying with it the striker and compressing the spiral spring, by a quantity equal to the projection of the screw-surface on the cock; this motion is complete when the stop-wedge on the cock enters the notch made to fit it on the cylinder—this is known by the click which occurs. The stop-stud presses against the hollow screw-surface of the groove on the cylinder, which latter is forced back, drawing with it the moveable cap and extractor, so starting the empty cartridge-case. From the above it is seen that the hammer receives two retrograde motions, one produced by the action of the notch in the cylinder on the screw-surface attached to the cock, the other from the pressure of the stop-stud on the screw-surface of the groove on the cylinder. By this double effect the rifle is cocked, the cartridge started, and the under groove of the cylinder is brought into its proper position, and the handle now being vertical, the entire breech-piece can be drawn back until arrested by the stop-stud, carrying with it the cartridge-case or cartridge, as the case may be; as the base of the latter strikes the bottom stud in the chamber, the upper extremity being held fast by the claw of the extractor; the effect of these pressures on the cartridge-case is to eject it forcibly.

2. The cartridge is put in in the usual way, and pressed home as tightly as possible.

3. The entire breech-piece is now pushed forward, and the lever turned from left to right, until down in its place. The rifle is then ready to be fired.

The effects produced by these motions are as follows:—

As the lever is pushed forward, the claw of the extractor slips over the base of the cartridge, and lays hold of it. The forward motion continues until the stop-stud abuts against the slope of the side groove, after which the lever can only be turned from left to right, which being done, the screw-surface on the base of the lever-handle slides on the corresponding screw-surface on fore part of the re-inforce of the breech chamber; by this means the moveable head is driven forward, and the cartridge firmly pressed into its place; the notch in the cylinder is disengaged from the stop-wedge attached to the cock, after which the cylinder turns freely until home, the forward motion of the hammer being prevented by the nose of the mainspring.

4. The trigger being pulled, the nose of the mainspring is depressed downwards, clears the hammer, and the latter being acted on by the spiral spring is carried forward, and with it the striker, and the charge is fired.

Safety Notch (Fig. 1).—In the experimental fire-arms supplied, a safety apparatus was used to prevent the rifles going off accidentally, but at the end of the experiments, and on the recommendation of the Commission such an apparatus was not considered necessary, and was consequently abandoned; it was, however, subsequently considered advantageous to be able to have the rifle loaded without being obliged to keep it on full cock. This was easily carried out by means of a notch

in a suitable position on the hammer, presenting also the advantage of relieving the pressure on the mainspring.

To put the rifle on half-cock, turn the lever partly to the left, the forefinger pressing the trigger, the thumb on the hammer, and allow the latter to slide forward until the click of the nose of the mainspring falling into the notch, is heard. The rifle is then half-cocked. To place the rifle on full-cock it is only then necessary to press the lever from right to left and then back into its proper place. The position of the safety-notch is determined in such a manner, that if the hammer does now go off, the striker has such a small space to go through, 1 mm. 5 = ·02 of an inch, and the pressure of the spiral spring is so weakened, that the striker has no longer sufficient force to explode the detonator.

Sights (Fig. 5).—The back sight is composed of two pieces, one fixed, the other sliding on it, and also of a base; the latter contains a spring, and is soldered on to the barrel. The sight revolves on the extremity of the base as an axis, and can be turned down to the front or rear, or can be maintained in a vertical position. The left side of the fixed part is graduated for every 25 metres, from 400 metres up to 1,200 metres; the right side is graduated from 1,400 to 1,800 metres. The sliding part is provided with a notch at each extremity.

In firing at 200 metres, the sight is turned down to the front, and the notch at the base of the sight is used. For 300 metres, the sight is turned down to the rear, and the notch at the lower end of the sliding part is used. For 350 metres, the sight is vertical, and the notch at the base of the fixed part is used, the sliding part being pulled up out of the way. For 1,300 metres, the same as for 350, but the line of sight passes through the notch at the top of the fixed part. For 400 metres, the sight is vertical, the sliding part is pushed down, and the line taken through the lower notch on the latter. For 1,400 metres, the slide is down, and the line of sight passes through its upper notch. For 1,800 metres, the slide is up, and the line of sight passes through its upper notch.

In some rifles the notches are on the right or on the left of the plane of fire, in order to correct the lateral deviation of the rifle.

The mountings of the rifle are very similar to those of the Chassepot; the ramrod is different, and is secured in its place by means of a screw at its end.

Sword-Bayonet.—The sword (*épée*) bayonet, with bronzed steel scabbard, was adopted, instead of the sabre bayonet, to lessen the soldier's load, and also to facilitate firing when the bayonet is fixed.

Cartridge.—The metallic cartridge adopted by the Commission is composed of four principal parts:—

1. Powder case.
2. The detonator.
3. The lubricator.
4. The ball.

The powder case is of brass-foil and contains 5·25 gr. = 81 grs. of powder. The base is of iron, and contains the detonating arrangement, which communicates with the powder by means of small holes.

The detonator is composed of the copper cap, containing the usual detonating composition, and a detonator-cover, to keep the cap in its place.

The lubricator is placed in the cartridge-case, between the powder and the bullet, and is composed of a disc of greased felt, between two cardboard discs.

The bullet is of pure compressed lead, and is surrounded with a paper covering.

Manufacture.—The date of issue, &c., of the cartridge is stamped on the base, and the cartridges are made up in paper packets of six each, the cartridges being separated by means of a strip of paper passing between them.

Dimensions of the different parts of the Cartridge.

Thickness of base	2·15 m.m.	
Length of case	37·30 m.m.	
Total length of case	39·45 m.m.	= 2·2 inches.
Projection of ball beyond case =	16·55 m.m.	
Total length of cartridge =	76 m.m.	= 3 inches.
Greatest diameter of base of cartridge	16·8 m.m.	
Least ditto ditto	13·5 m.m.	
Greatest diameter of cartridge case	13·75 m.m.	
Least ditto ditto	11·75 m.m.	
Weight of case =	12·9 gr.	= 198 grs.
Diameter of bullet at the base =	11 m.m.	
Length	27 m.m.	
Weight	25 gr.	= 386 grs.
Total weight of cartridge =	43·8 gr.	= 676 grs.
Weight of 10 cartridges =	$15\frac{1}{2}$ oz.	

Ballistic Qualities.—The following table shows the initial velocities of the new pattern rifle compared with those of the '66 pattern:—

Arms.	Pattern '66.	Pattern '74.
	m.	m.
Transformed rifle	420	450
Carbine	405	435
Musket	390	415

There results from this augmentation of velocity an increase in range and a flatter trajectory, without a corresponding increase in recoil. Rapidity of fire is also increased, due to the automatic action of the lock. Accuracy of fire is also increased.

The following tables show the trajectories of the new rifle, for different ranges:—

TABLE I.—*Heights of Trajectory above the Line of Sight.*

At distances of	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	450	500 Metres
Metres range																		
200	·14	·25	·32	·36	·35	·28	·17	0	-·23	-·53	-·89	-1·28	..	-2·34	..	-3.57		
300	·23	·45	·67	·77	·86	·92	·92	·82	·74	·61	·30	0	·40	·85	-1·34	-1·88		
400	·35	·70	1·04	1·24	1·47	1·60	1·75	1·78	1·79	1·73	1·59	1·40	1·24	·78	·44		-1·00	-2·61 Metres

TABLE II.

Distance. Metres.	100 Met.	200 Met.	300 Met.	400 Met.	500 Met.	600 Met.	700 Met.	800 Met.	900 Met.	1,000 Met.	1,100 Met.	1,200 Met.	1,300 Met.	1,400 Met.	1,500 Met.	1,600 Met.	1,700 Met.	1,800 Metres
200....	·36	0	-1·28															
300....	·77	·82	0	-1·88														
400....	1·24	1·78	1·40	0	-2·61													
500....	1·76	2·80	2·96	2·09	0	-3·36												
600....	2·32	3·02	4·76	4·36	2·81	0	-4·62											
700....	2·98	5·24	6·62	6·98	6·11	3·97	0	-5·70										
800....	3·70	6·67	8·77	9·85	9·69	8·26	5·00	0	-7·05									
900....	4·48	8·24	11·12	12·98	13·61	12·96	10·48	6·27	0	-8·60								
1,000....	5·34	9·96	13·70	16·42	17·91	18·12	16·50	13·15	7·74	0	-10·33							
1,100....	6·28	11·84	16·52	20·18	22·61	23·76	23·08	20·67	16·20	9·40	0	-12·27						
1,200....	7·30	13·88	19·58	24·26	27·71	29·88	30·22	28·83	25·39	19·61	11·24	0	-14·41					
1,300....	8·40	16·10	22·90	28·70	33·25	36·53	37·98	37·70	35·36	30·69	23·42	13·70	0	-16·80				
1,400....	9·60	18·40	26·50	33·50	39·25	43·73	46·38	47·30	46·16	42·69	36·62	27·69	15·59	0	-19·41			
1,500....	10·90	21·08	30·38	38·67	45·72	51·50	55·44	57·65	57·80	55·63	50·86	43·22	32·42	18·12	0	22·28		
1,600....	12·29	23·87	34·56	44·24	52·68	59·85	65·38	68·79	70·33	66·55	66·17	59·93	50·51	37·61	20·88	0	-25·23	Metres
1,700....	13·78	26·84	39·02	50·28	60·10	68·75	75·57	80·66	83·69	84·39	82·49	77·74	69·80	58·39	43·04	23·74	0	-28·96
1,800....	15·39	30·06	43·84	56·61	68·15	78·40	86·84	93·53	98·17	100·48	100·19	97·04	90·72	80·91	67·27	49·49	27·36	0

TABLE III.

Distances in metres.	Angles of Elevation in degrees.	Angles of Descent in degrees.	Dangerous space for Infantry. H. 1·70 m.	Dangerous space for Cavalry. H. 2·50 m.	Time of Flight. sec.	Final Velocities in metres.
0	0° 0′ 0″	0° 0′ 0″	..	..	0	450
100	0° 10′ 56″	0° 11′ 40″	..	..	0·24	391
200	0° 23′ 24″	0° 26′ 34″	..	..	0·51	346
300	0° 37′ 33″	0° 45′ 6″	130	190	0·81	310
400	0° 53′ 31″	1° 7′ 37″	86	127	1·15	281
500	1° 11′ 25″	1° 34′ 29″	62	91	1·52	257
600	1° 31′ 33″	2° 6′ 4″	46	68	1·92	237
700	1° 53′ 32″	2° 42′ 46″	36	53	2·36	220
800	2° 18′ 1″	3° 24′ 51″	28	42	2·83	205
900	2° 44′ 56″	4° 12′ 38″	23	34	3·33	192
1,000	3° 14′ 26″	5° 6′ 24″	19	28	3·87	181
1,100	3° 46′ 37″	6° 6′ 6″	16	23	4·44	171
1,200	4° 21′ 35″	7° 12′ 3″	13	20	5·04	162
1,300	5° 59′ 28″	8° 24′ 17″	11	17	5·68	154
1,400	5° 40′ 22″	9° 42′ 40″	10	14	6·35	147
1,500	6° 24′ 23″	11° 7′ 2″	9	13	7·05	141
1,600	7° 11′ 37″	12° 36′ 44″	8	11	7·79	136
1,700	8° 2′ 7″	14° 11′ 24″	7	10	8·56	131
1,800	8° 55′ 59″	15° 50′ 32″	6	8	9·36	126

The times of flight were determined as follows: two observers, each provided with a stop chronometer, placed themselves mid-way between the target and the firer, and noted, one the report of the rifle, and the other the sound of the impact of the bullet on the target. The difference between the two times gave the time of flight.

Table showing comparative Ballistic Properties of the different Rifles now in use in the Armies in Europe.

Pattern.	Calibre.	Weight of Bullet.	Initial Velocities.
	Inch.	Grains.	Feet.
France { 1874	·433	385	1,476
France { 1876	·433	385	1,378
Germany, 1871, Mauser	·433	385	1,469
England, 1871, Martini-Henry	·45	480	1,312
Austria { 1867, 1873, Werndl	·421	310	1,400
Austria { Do. do.	·421	370	1,476 with new cartridge
Bavaria { 1869, Werder	·433	340	1,444
Bavaria { Do. do.	·433	385	1,460 with German do.
Italy, 1870, Vetterli	·409	308	1,397
Russia, 1871, Berdan	·421	370	1,420

The examination of the last table shows that, with the exception of Italy and England, all the European powers have adopted, as did France in 1866, a small-bore rifle, varying in calibre from ·421 to ·433 inches, firing a bullet of between 370 and 385 grains, with an initial

velocity of from 1,476 to 1,400 feet per second. The results obtained by these rifles are, moreover, so nearly equal, in regard to rapidity of fire and ballistic qualities, that it may be said now, as in the days of the old smooth-bore, that European armies are almost equally well armed, and that hereafter, as in the past, success will depend above all on the use made of the rifle provided, and hence that all our efforts should be directed towards teaching the soldier to make the best possible use of it. It is necessary to bear in mind, in practising with any rifle, that the initial velocity of the bullet, the trajectory described, and, in consequence, the elevation of the rifle, are not constant quantities. According to season, temperature, barometer, &c., these quantities are subject to considerable variation, and a change of temperature equal to 20° C, often causes the bullet to strike 16″ above or below the mark aimed at, at a range of 200 metres.

NOTES ON NAVAL MATTERS.

The Projection of Gun-muzzles beyond the Sides of Ships.

Now that the number of guns with which the most powerful ships are armed is being usually reduced to about four in turret ships, and half-a-dozen in broadside ships, and all of them, in both cases, are being mounted upon more or less delicate machinery, the question of the degree to which their muzzles project from the ship's side is becoming one of importance. In our "Inflexible" the guns, when run out, will project several feet beyond the side, owing to the turrets being placed near to the side, in order to facilitate bow and stern fire. It is obvious that an enemy, by simply steaming past her while the guns are run out, might inflict great injury upon the machinery of both guns and turrets; and although it may be said that the turret and guns can be turned away, or that an enemy would expose herself to great danger by attempting this manœuvre, still it is not by any means impossible that a skilful and daring enemy might contrive in this way during an action, to cripple the great ship, and even to put her turrets and guns *hors de combat*.[1] Even a vessel of extremely inferior power, if well handled, might accomplish this if no provision were made against it. The Admiralty and its advisers have recognised the force of these considerations by providing for the "Inflexible" being fitted with fixed external sweep-pieces, or curved fenders, in wake of the turret, on either side, for glancing or turning aside an enemy's blow; and although the efficacy of this remedy may, in some easily-conjectured cases, be doubted, the adoption of the device shows that the Government are sensible of the risk involved, and have taken the best available means of diminishing it. It is curious to note how differently this practical source of danger has been dealt with in the Italian and in the Austrian Navies, which shared in the only practical experience of ironclad warfare that Europe has afforded. In the Italian turret ships "Duilio" and "Dandolo" the turrets are placed ex-

[1] In a discussion on Naval Tactics, at this Institution, on the 31st May, 1875 (*Vide* Journal, Vol. IX, No. 82, page 516, *et seq.*), Admiral Sir Henry Codrington mentioned the account given him by the Commander of a German gunboat, of the action between his vessel and a French gunboat, off the Havannah, when he described the effect of the stem of the Frenchman raking along his ship's side, and not only carrying away the channels, so that his rigging was cut away and his masts came down and fouled his screw, but also struck, capsized, or turned round his three guns, which he was ready to fire into the Frenchman.—Ed.

tremely near to the side, and the guns being very long, their projection beyond the side will be very great,—we have heard it said that it will be as much as 11 feet, with the guns run out. We cannot vouch for this, nor do we think the projection can well be so great, even with the 100-ton guns, but it will be so great as to make it exceedingly difficult to fully remedy the defect by permanent projecting sponsons like the sweep-pieces of the "Inflexible." In the Austrian navy, on the other hand, which is presided over by an officer, Admiral Pöckh, who highly distinguished himself at Lissa, and in which we observe many evidences of practical improvement, the very opposite remedy is resorted to. In the design of the new and powerful ironclad "Tegethoff" now building at Trieste, the side with its armour is indented curvilinearly to a sufficient depth to provide for the gun muzzles being always within the general line of the ship's side, even when the guns are run out. It has been suggested that the real object of this was that for which a similar arrangement has before now been proposed in this country, viz., that of giving great lateral training to the gun with a comparatively small port. That this object also is furthered by the plan we do not deny; but it was not for this purpose that the recession of the side was actually resorted to. This fact has been decisively established, and the true object of the Austrian authorities clearly affirmed by the designer of the ship, Chief Constructor Herr Romako, who, in a letter addressed to Mr. Reed (and cited by him at the Institution of Naval Architects), said, "The ship "'Tegethoff' is in many regards a novelty, its casemate allowing an "all-round fire, *avoiding, at the same time, by its particular form, the "dangerous projection of the muzzles of the midship guns, in consequence "of experience acquired in the battle of Lissa, but which are very little "known, even in our own navy.*" These words are as decisive as they are important, and show that we have actual experience in war to confirm the views above expressed. It may be inferred from the difference of procedure in the two navies, in respect of this matter, that the battle of Lissa did not convey the same lessons to both of the combatants.

The New Austrian Ironclad "Tegethoff."

A brief summary of the characteristics of this important ship, now under construction at Trieste, as the latest embodiment of Austrian naval opinion, will be interesting to our readers. We may mention that she is, in a peculiar degree, the embodiment of naval opinion in Austria, inasmuch as her design is the consequence of the prolonged inquiries and deliberations of a very carefully selected Committee which sat for several months at Trieste, although Herr Romako, the Chief Constructor of the Vienna Admiralty, is no doubt personally responsible for the technical details, and for the calculations of the ship. In a paper presented to the Institution of Naval Architects a few weeks ago, Mr. Reed gave the following general dimensions and particulars of her: "Length between the perpendiculars, 286ft. 11½in.; length, "total, 303ft. 1¼in.; breadth on the water-line, 62ft. 9in.; extreme

" breadth to outside of armour, 71ft. 1½in. ; depth of hold, 34ft.9 in. ; " draught of water, aft, 26ft. 7½in. ; draught of water, forward, 23ft. " 1in. ; displacement with the half of provisions, 7,390 tons; area of " the midship section, 1,301 square feet; area of the load water-line, " 14,308 square feet; height of metacentre above centre of gravity of " displacement, 14·623ft; height of metacentre above water, 4·770ft. ; " distance of the centre of gravity of displacement before the midship " section, 0·356ft; depth of the centre of gravity of displacement " below water, 9·853ft; co-efficient of displacement, 0·582ft. ; co-effi- " cient of water-line, 0·782ft. ; co-efficient of midship section, 0·82ft. ; " displacement of an inch immersion at the load water-line, 34·47 tons; " weight of armour and backing, 2,160 tons; the armament consists " of six 11in. Krupp guns. Area of sails, 12,165 square feet; cost of " hull, estimated, 172,790*l.* ; cost of engines and boilers, estimated, " 81,715*l.* ; nominal horse-power, 1,200; number of cylinders, 2; dia- " meter of cylinder effective, 125in. ; length of stroke, 4ft. 3in. ; " Griffith's propeller, diameter, 23ft. 6in. ; pitch, 24ft. ; number of " blades, 2; revolutions per minute, 70; number of boilers, 4; area of " fire-grate, 850 square feet; heating surface, 25,500 square feet; " superheating surface, 1,800 square feet ; pressure of steam, 30 lb. ; " number of furnaces, 36 ; mean indicated horse-power, 8,000 ; speed, " estimated, 14 knots. From these figures it will be seen that " although we are not dealing with a ship of the 'Inflexible' (Eng- " lish) or of the 'Dandolo' (Italian) type, in which armour of exces- " sive thickness is placed over a central citadel of extremely limited " extent, we nevertheless have a very powerful ship indeed, with " armour of apparently about 13in. to 14in. thick, and with a concen- " trated battery of six 11in. Krupp guns, each weighing, I presume, " about 27 tons. The ship has a belt of armour extending from the " stern to within about 30ft. of the foremost perpendicular, where it " terminates in a transverse armoured bulkhead, and a stout iron deck " going forward to the stem at about 7 feet below water." The "Tegethoff" has a long projecting under-water spur—it projects 9 feet from the stem at the load water-line, and 19 feet from the stem-head. Nearly all double curvature is excluded from the armour plates. The battery is of the projecting type adopted by Mr. Reed in the upper decks of the "Audacious" class, and on the main decks of the German and Chilian ironclads designed by him. The battery is traversed by a bulkhead which cuts off the two foremost battery guns from the remainder, after the plan adopted by Mr. Barnaby in the "Alexandra." The ports are thrown back from the outside of the side, as explained in a previous paragraph.

The Port and Dockyard of Venice.

Considerable expense is being incurred by the Italian Government in the improvement of the Dockyard at Venice, and in the port and its approaches. When there last year, we had an opportunity of inspecting the new graving docks, one of which was being constructed of concrete in a novel manner. The use of concrete itself is not, of course,

any longer a novelty in dock construction, but in this case the floor of the dock was being formed of concrete in the water. The bottom was excavated to a sufficient depth (much exceeding the required depth of the dock), and then concrete, in a wet state as mixed, was being deposited over the whole floor. A descending hopper, which opened only when the bottom was nearly reached, was employed for the purpose, and was made to deposit successive charges side by side by means of an overhead crane, which travelled across the dock, floated upon pontoons, which were moved along the dock longitudinally as required. We were informed at the time that the new docks, although of no great depth, were considerably deeper than the approaches; and great differences of opinion appear to exist among Italian engineers as to the practicability of improving, and as to the means of improving, the Venetian channels. Professor G. Lanon has published in the *Revista Maritima* an interesting discussion upon the dockyard approaches, and upon schemes for improving them, a summary of which is translated and printed in the newly issued volume of the *Proceedings* of the Institution of Civil Engineers (vol. 43, p. 363). The wonder is, that in a place like Venice, the Government does not have recourse to the system of hydraulic lift with pontoons, such as is in use in this country and at Malta and Bombay; or else of the tubular hydraulic dock of Messrs. Clark and Stansfield. By this means they would be able to place their ships upon pontoons in the deep water near the sea, and then transport them to the dockyard establishment, and back again, with the greatest ease.

Imperial German Frigates.

The two principal ironclads in the Imperial German squadron, now in the Mediterranean, are the "Kaiser" and "Deutschland." These are sister ships, built in England, and completed in March and August respectively last year. Their principal dimensions are—length between perpendiculars, 280 feet; breadth, extreme, 62 feet 8 inches; depth in hold, 37 feet 6 inches; displacement, 7,300 tons; extreme draught of water, 24 feet. The engines, by Messrs. John Penn and Sons, of Greenwich, are horizontal trunk surface condensing, fitted with superheaters, steam starting gear, &c., with a boiler pressure of 30 lbs., and are capable of developing 8,000 indicated horse-power. The mean speed at full power, when tried at the Maplin Sands, was $14\frac{1}{2}$ knots, and at half-boiler power $13\frac{1}{4}$ knots. In these vessels Mr. Reed has introduced an arrangement by which when the screw is disconnected for sailing, the weight of the screw and after-piece of shaft may be taken on friction rollers, and it is hoped that this arrangement may considerably reduce the dragging power of the screw when the ships are under sail alone. The armament is of Krupp's guns and consists of eight 26 cm. ($10\frac{1}{4}$-inch) 22-ton guns in the midship battery, and one 21 cm. ($8\frac{3}{4}$-inch) $9\frac{3}{4}$-ton gun in the stern battery. These guns are on the main deck, a few small guns for saluting purposes being carried on the upper deck in addition. The midship battery overhangs the side, and is so arranged that the foremost gun on either side is capable of firing 2° across the

keel, the fire from the two guns converging about three ships' lengths ahead. The aftermost gun on either side of the battery can be trained to within 15° of the keel, from which point the fire is taken up by the stern gun, so that the advantage of an all-round fire is secured. The thickness of armour at the water-line in wake of engines, boilers, and magazines is 10 in., elsewhere amidships 8 in., tapering to 5 in. at the stem and stern on the belt. The armour on the midship battery is 10 in. at the port sills and 8 in. elsewhere, and on the stern battery 8 in. The vessels are ship-rigged, the area of plain sail being 29,000 square feet. They are equipped with steam steering-gear, steam capstan, auxiliary fire-engine, and very efficient pumping and ventilating arrangements. Mr. Reed has carried his principle of broadening and shortening ships farther in these vessels than in any of his previous designs, the proportions of length to breadth being $4\frac{1}{2}$ to 1, and they must certainly be classed among the most successful of his ships, the designed speed of 14 knots having been exceeded by half a knot, and the steering powers proving, as might be expected, extremely good.

The Chilian Ironclads "Almirante Cochrane" and "Valparaiso."

The Chilian ironclads, "Almirante Cochrane" and "Valparaiso," are sister ships, built from Mr. Reed's designs by Earle's Shipbuilding and Engineering Company, Hull. They were completed last year. The principal dimensions are—length between perpendiculars, 210 feet; breadth, extreme, 45 feet 9 inches; depth in hold, 28 feet 10 inches; displacement, 3,400 tons. The engines are by Messrs. John Penn and Sons, of Greenwich, and are twin screw on the compound principle, with horizontal cylinders and surface condensers. They develop collectively 3,000 indicated horse-power, giving a mean speed of 13 knots. The armament consists of six $12\frac{1}{2}$-ton guns by Sir W. Armstrong and Co., in a midship battery. The battery is arranged with embrasures, so that the foremost gun on either side can fire right ahead, and the aftermost gun on either side right astern, with sufficient training to enable them to fire slightly abaft and before the beam respectively. The midship gun on either side also fires from an embrasure port which gives it a training of from 20° abaft the beam to 70° before it. The armour on sides is 9 inches at the water-line and 6 inches elsewhere amidships, tapering forward and aft. On the battery the armour is 8 inches at the port-sills and 6 inches elsewhere. Protective deck plating $\frac{3}{4}$ inch thick is fitted before and abaft the battery on the main deck. These ships are barque rigged, and carry 12,000 square feet of plain sail.

The Imperial Brazilian Ironclad "Independencia."

The Imperial Brazilian turret-ship "Independencia" was ordered in 1873, the contract for building her being given to Messrs. J. and W. Dudgeon, of Poplar, the duty of inspecting the building being undertaken by Brazilian officers. Owing to an unfortunate failure at the first and second attempts to launch her, by which she was very much

injured, and the subsequent failure commercially of Messrs. Dudgeon's firm, she is still in a very unfinished state, in the large dock at Woolwich Dockyard. The necessary repairs and the work of completing her are now, however, being carried on, and it is hoped that she will be completed in about a year's time. The principal dimensions are—length between perpendiculars, 300 feet; breadth, extreme, 63 feet; depth in hold, 28 feet 10 inches; displacement, 9,000 tons; extreme draught of water, 25 feet. The engines are by Messrs. John Penn and Sons, of Greenwich, similar to those in the "Kaiser," and "Deutschland," but to develop 8,500 indicated horse-power. The armament is four 35-ton guns, carried in two turrets, and two 8-ton guns on the upper deck forward. The guns are made by Sir Joseph Whitworth of steel. One of the 35-ton guns has been tried in France by the French Government officials, and the publication of their report is awaited with much interest. The armour on sides amidships is 12 inches and 10 inches; on battery, 9 inches and 8 inches; on the bow battery, 8 inches and 6 inches; and on the pilot tower, 8 inches and 6 inches. Protective deck plating is fitted on the main deck before and abaft the battery, the thickness being 3 inches amidships and 2 inches forward and aft. The "Independencia" is to have large sail-power, and be in every respect a sea-going turret-ship. She is designed to have a freeboard of 11 feet to the upper deck, and will be fitted with falling-down topsides. A poop and forcastle are to be fitted, and the ropes are to be worked on a flying deck entirely over the turrets. Steam steering and capstan gear will be provided, also steam and hand turning gear for the turrets, and the turret guns are to be loaded by Sir W. Armstrong's hydraulic machinery.

Japanese War Ships.

The Imperial Japanese Government is having an ironclad corvette built in this country. She is of 3,700 tons displacement, 220 feet length between perpendiculars, 48 feet breadth, extreme, and 28 feet 8 inches depth in hold. Her engines are to be on the compound principle, twin screws, with horizontal cylinder and surface condensers. They are to develop 3,500 indicated horse-power, and are estimated to drive the ship at 13 knots. The armament is to be supplied by Krupp, and will comprise four 24 cm. ($9\frac{1}{4}$-inch) 15-ton guns, to be carried in a midship battery on the main deck, and two 17 cm. ($6\frac{3}{4}$ inches) $5\frac{1}{2}$-ton guns on the upper deck. The upper deck guns are carried amidships and are arranged to fire right ahead, on the broadside, and right astern. They are unprotected. The battery guns are placed at the four corners of the battery, and have very considerable fore and aft training in addition to the broadside fire. The armour on sides is 9 inches at the water-line and 7 inches elsewhere amidships; on the battery 8 inches at the port sills and 7 inches elsewhere. The vessel is to be barque-rigged, with about 12,000 square feet of plain sail. The same Government is also having built here two composite corvettes, which are to have a thin strake of armour ($4\frac{1}{2}$ inches) at the water-line in wake of engines.

THE ROYAL NAVY OF ENGLAND AND THE STATE NAVY OF FRANCE.

The following important communication on this subject has been contributed by a distinguished Naval Officer, who derived the information from a highly-placed foreign Official.—L. A. H.

1. An admirable article in the *Quarterly Review* (January, 1876), on British Shipping and Seamen, may perhaps be usefully supplemented by a statement showing how the French Government, by their system of War Reserves established by the great Colbert, not only provides, *first*, for an expansion in time of war, which will include, if necessary, nearly the whole of their merchant seamen and fishermen, but also, *secondly*, that during the process of drilling each man for three years at least, in a man-of-war, the whole body of French merchant seamen and their Officers shall be raised to a level much higher than that occupied by most of our merchant seamen as to intelligence and steadiness, which means safety, economical management, &c. We will first compare the ship's companies of an English and a French ironclad, and then the Naval Reserves of the two countries.

I.—The Ship's Companies.

2. There are remarkable differences in the composition of the ships' companies in French men-of-war and English men-of-war; the proportion of combatants in the former is much larger than in the latter, viz., 95 per cent. of the whole ship's company, whereas in the English ship-of-war only 75 per cent. are combatants, and of these, 9 per cent. are marines and 10 per cent. are boys.

3. An English ironclad of the "Vanguard" class has a complement of about 41 Officers, 60 marines, 46 boys, and 314 seamen, domestics, artificers, stokers, &c., but of the latter only about 197 are drilled to the use of weapons, leaving 117 artificers, stokers, domestics, &c., undrilled, or 25 per cent. of the whole crew of 461; whereas a French ironclad, of about the same class, will have only 5 per cent. non-combatants; and of the English Officers, none of the non-executives are taught, or expected to know, how to use the sword they carry. With a crew of 461, the French will have only 23 non-combatants, and 438 combatants, opposed to 344 English combatants, and nearly all the French combatants will be seamen; instead of marines, they have *matelots fusiliers*, and no boys; of the stokers even, a large proportion are seamen.

4. There can be no doubt, therefore, that (leaving out the question,

for the moment, the disputed point whether it is better to have "marines" or "matelots fusiliers") a French ship's company, *as far as its composition is concerned*, is much more efficient for *general war purposes* than, *cæteris paribus*, one of our own.

5. The above system, which provides for so very large a proportion of the ship's company being seamen, facilitates the drilling of the reserves, and enables the French nation to present her "outer line" of defence in a state of preparation, which is at once their boast and pride, and ought to be our envy, but I do not believe one Englishman out of ten thousand, or more than one member of the House of Commons, is really aware of what the French Reserve of seamen consists. It is well they should know it, in view of future probabilities.

II.—The Reserves.

6. The number of Officers and seamen afloat in the active service of France, together with those seamen whose names are on the list of the *Inscription Maritime*, and who are between the ages of twenty and forty, and have been for between three and five years on board a man-of-war, carefully instructed and drilled, is over 68,000! These seamen can at any time be recalled for further service, in case of war. The large majority of them are in France, in the coasting trade, fisheries, &c. The French merchant service is small, and, I believe, nearly stationary in numbers, but from it and from other seafaring classes, 7,000 men pass annually into the French Navy, and are retained for from three to five years; they join French men-of-war abroad. For this purpose, the legal claim on them commences at twenty and ends at forty-five; but as a matter of fact they are not retained after forty.

In the Crimean war, the number of Officers and men on active service was over 63,000.

In the German war, the number was 67,786. Of this number 28,740 were at Paris.

There were also at Paris 28,507 *marins*, or colonial soldiers (infantry and artillery), not including 13,000 left in the colonies.

The *marins*, most of whom have made long voyages, could be embarked as are our marines, for service on board ship, if necessary, swelling the number of Officers and men available for service in the fleet at the commencement of the German war to 96,283, without withdrawing the *marins* in the colonies.

It is evident that a large reserve of *Officers* would be required; this is amply provided for. More than 2,000 *capitaines de long cours* (merchant captains) and 3,000 captains of coasters, all of whom have passed from three to five years in the State Navy, and the former of whom (the *capitaines de long cours*) have had to pass a stiff examination—form the Reserve of Officers.

Note.—The contrast in acquirements, manners, and habits between a French *capitaine de long cours* and the ordinary master of an English merchant vessel is most unfavourable to the latter, and it can, therefore, be no matter of surprise that the crew of the English ship is, as a

general rule, in all but the first class "employs," thoroughly unsatisfactory, although there are other causes at work to bring about this most undesirable result.

7. The English Reserves consist of in round numbers—

4,000 Coast Guard men, chiefly petty officers, good seamen, well drilled.

15,000 Royal Naval Reserve men, and 2,000 Coast Volunteers; the former fair seamen, of whom perhaps about 9,000 are always in England; the latter fishermen.

1,000 Royal naval Artillery Volunteers.

6,000 Marines in barracks.

The seamen and marine pensioners available on account of age would probably be disposed of, as in our war with Russia, in replacing the Coast Guard men at their stations, manning harbour ships, and as riggers in dockyards.

Reserves of Officers:—

102 Lieutenants, Royal Naval Reserve,
91 Sub-Lieutenants,
74 Midshipmen,
} imperfectly drilled.

and about 200 chief Officers of Coast Guard, who have risen from the seamen class.

Retired Naval Officers.

8. There can be no doubt that, as regards Reserves of disciplined seamen drilled to the use of arms, the French are very much better off than we are, probably at least 100 per cent. better, especially when we consider that in time of war with a European power, or the United States, we should have to send numerous men-of-war to all quarters of the world, and provide for the manning of fast hired steamers, carrying a considerable stock of coal, armed for the occasion to act as convoy to our fleets of merchant vessels. As regards Reserves of Officers, the French are immeasurably better supplied; there is no comparison between us.

9. It may be said that large Reserves of seamen and of Officers are useless, if there are no ships to place them in, and that as our *ironclad* fleet is equal in number to that of the French, and superior in individual strength, we may content ourselves if we can man and officer our fleet; but ironclads can be sold, bought, borrowed, stolen! The ironclad fleet of Turkey, said to be the third in strength in Europe, and designed, I believe, by English Admiralty Constructors, might change owners as promptly and unexpectedly as the Khedive's shares of the Suez Canal, and the number of French ironclads be doubled in a few minutes, by the transmission of a few words by the electric telegraph to Constantinople from Paris.

10. It may be said that France is now, from interested and, therefore, from the most weighty motives, our most devoted ally, and must, of political necessity, remain so for many years. This is begging the question, but certainly Germany is not so situated, and if hard pressed by us, we being in alliance, say with Russia, Germany could easily

bait a hook, which would draw France to her side with unfailing certainty, viz., by offering to resign some of her late acquisitions.

11. There is growing and deepening conviction that obligatory military service, in some shape or other, modified probably when compared with the Prussian and French system, will be enforced on Englishmen on shore. This may or may not be practicable, and if practical, it may or may not be a wise step; but if it is attempted, seafaring men of every description will have to take their share of the infliction, and, of course, their service must be *afloat*. In that case our Reserves of seamen from the merchant service, coasting trade, and off-shore fishermen, if disciplined and drilled as are the French Reserves, will far outnumber them, and the marines might then be absorbed or become colonial corps for the Crown colonies.

12. When this question of obligatory military service is under the consideration of the Government, and the Naval portion of it is being discussed, the above information may, perhaps, be found useful.

NOTICE OF BOOKS.

Instructions for the Cavalry Regiments about to take part in the Exercises of the Combined Cavalry Division detailed from Regiments. By Major-General Von Schmidt. Translated by Major-General Walker, C.B.: Blackwood & Sons, Edinburgh and London.

"I have nowhere but in Verdy's 'Studien,' in section 5, and in these "Instructions of General Von Schmidt, found what I have long sought "for, namely, a clear definition, not only of the duties of cavalry in "large bodies, but also of the ways and means by which these large "bodies can be practically utilised. . . . . I am of opinion that since "the days of the great Frederick no such master of the art of lead-"ing cavalry has appeared as the late General von Schmidt."

Such is the high praise accorded to this distinguished cavalry Officer by General Walker in the short preface to this pamphlet. The Instructions were intended for the use of the Division which General von Schmidt was to have commanded in the autumn of last year, had he not been prematurely removed by death.

By the courtesy of the editor and publisher at Berlin, the Instructions were placed at the disposal of General Walker, who has done the British cavalry good service by translating them and making them public. We commend them to the close attention of all cavalry Officers. We hope to be able to notice them at greater length on a future occasion.